# RESPONSE OF DILL SEED (*Anethum graveolens* L.) TO IRRIGATION AND WEED MANAGEMENT PRACTICES UNDER MIDDLE GUJARAT AGRO CLIMATIC CONDITION

A
THESIS
SUBMITTED TO THE
ANAND AGRICULTURAL UNIVERSITY
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE

OF
*Doctor of Philosophy*
(AGRICULTURE)



IN
**AGRONOMY**

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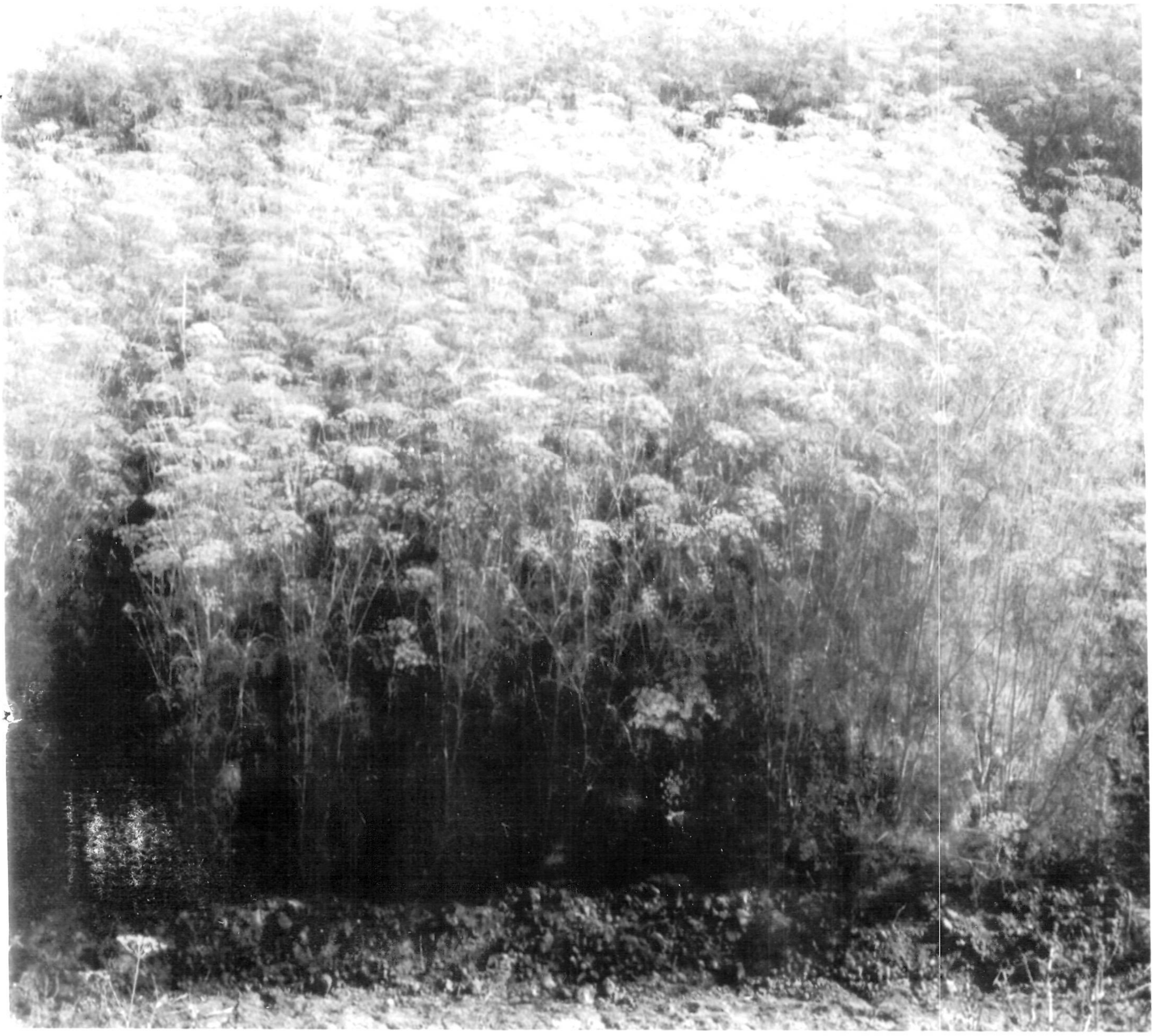
( Regn. No. 04 – 4886 – 2001 )


DAUGHTER



# Abstract

# RESPONSE OF DILL SEED (*Anethum graveolens* L.) TO IRRIGATION AND WEED MANAGEMENT PRACTICES UNDER MIDDLE GUJARAT AGRO CLIMATIC CONDITION

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## ABSTRACT

A field experiment was conducted at the Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand during two consecutive *rabi* seasons of the year 2002-03 and 2003-04 with a view to study the **"Response of dill seed (*Anethum graveolens* L.) to irrigation and weed management practices under middle Gujarat Agro climatic condition"**. The soil of the experimental field was sandy loam in texture with 7.5 to 7.8 pH and having a good drainage. The soil was low in organic carbon and available nitrogen, medium in available phosphorus and high in potassium. The experiment comprised of combinations of four irrigation schedules based on critical growth stages *viz.,* $I_1$ (irrigation at vegetative stage), $I_2$ (irrigation at vegetative stage and at 50 % flowering stage), $I_3$ (irrigation at vegetative stage, at 50 % flowering stage and at dough seed stage), $I_4$ (irrigation at 0.40 IW : CPE) and seven weed management practices *viz.,* $W_1$ (fluchloralin 1.0 kg ha$^{-1}$ as pre emergence), $W_2$ (pendimethalin 1.0 kg ha$^{-1}$ as pre emergence), $W_3$ (metolachlor 1.0 kg ha$^{-1}$ as pre emergence), $W_4$ (oxadiargyl 100 g ha$^{-1}$ as pre emergence), $W_5$ (HW

at 3 WAS and earthing up at 6 WAS), $W_6$ : Weed free (HW at 3 and 6 WAS) and $W_7$ (Weedy check). These treatments were laid out in Split Plot Design (SPD) with four replications.

Result revealed that the germination of dill seed recorded at 10 DAS and the plant population at harvest was not influenced by various irrigation schedules. The growth characters of dill seed crop *viz.,* plant height and number of branches plant$^{-1}$ as well as yield attributes such as umbels plant$^{-1}$, umbellates umbel$^{-1}$ and seeds umbellate$^{-1}$ showed significant improvement with irrigation scheduling at 0.40 IW : CPE ($I_4$).The various irrigation schedules failed significantly in influencing the days to 50% flowering. Test weight remained unchanged by irrigation scheduling during individual year but found significantly higher under treatment $I_4$ in pooled analysis. Improvement in vegetative growth of crop under $I_4$ irrigation schedule brought concomitant improvement in seed and straw yields. Similarly, significantly higher harvest index was recorded under treatment $I_4$, which was at par with $I_3$.Significantly higher nutrient uptake was registered under treatment $I_4$ (0.40 IW : CPE). Treatment $I_3$ (irrigation at vegetative, 50 % flowering and dough seed stages) reported significantly highest oil content (2.70 %) in dill seed at harvest. The weed population remain unaffected due to various irrigation schedules. The lowest water use efficiency was noticed with treatment $I_4$ which was at par with $I_3$ during individual years. The highest net return of Rs. 8078 ha$^{-1}$ and CBR of 1: 1.57 were secured at 0.40 IW : CPE ($I_4$) followed by irrigation given at 3 critical stages ($I_3$).

Growth and yield attributes *viz.,* plant height recorded at 12 and 18 WAS and at harvest, number of branches, number of umbels plant$^{-1}$, umbellates umbel$^{-1}$ and seeds umbellate$^{-1}$ were significantly higher in treatment $W_6$ (HW at 3 and 6 WAS). While lower under the treatment $W_7$ (weedy check) in individual years and in pooled analysis. Among herbicidal treatments, pre emergence application of fluchloralin 1.0 kg $ha^{-1}$ as PE ($W_1$) registered significantly higher number of yield attribute parameters over other herbicidal treatments. Significantly the highest seed yield (2073 kg $ha^{-1}$), straw yield (17135 kg $ha^{-1}$) and nutrient uptake (N, $P_2O_5$ and $K_2O$) by dill seed were observed in treatment $W_6$ (HW at 3 and 6 WAS). However, the effect of weed management practices on the test weight was not noticed. Significantly minimum weed density and dry weed weight recorded at various intervals were registered with weed management treatment $W_6$. Among herbicidal treatments, $W_1$ (fluchloralin 1.0 kg $ha^{-1}$ as PE) proved superiority in controlling weeds over other herbicidal treatments while, $W_4$ (oxadiargyl 100 g $ha^{-1}$ as PE) was the most inferior among herbicidal treatments. The highest net return of Rs. 15471 $ha^{-1}$ and CBR of 1: 2.21 were recorded with HW at 3 and 6 WAS ($W_6$) followed by HW at 3 WAS and earthing up at 6 WAS ($W_5$) and fluchloralin 1.0 kg $ha^{-1}$ as PE ($W_1$).

The treatment combination $I_4W_6$ proved statistically superior over other combinations of I x W in respect of plant height recorded at 18 WAS (180.00 cm) and at harvest (184.50 cm), number of branches $plant^{-1}$ (15.65) and number of umbellates $umbel^{-1}$ (28.56) at harvest.In pooled analysis, significantly higher seed yield (2376 kg $ha^{-1}$) was recorded with combination of $I_4W_6$ which was statistically at par with $I_3W_6$ (2248 kg $ha^{-1}$). Treatment combination $I_4W_6$ also recorded significantly the highest N (42.20 kg $ha^{-1}$) and $P_2O_5$ (13.17 kg $ha^{-1}$) and $K_2O$ (6.96 kg $ha^{-1}$) uptake by seeds.

From the above findings, it is concluded that for accruing maximum yield and economic advantage, dill seed crop should be irrigated either at all the critical crop growth stages (vegetative stage, 50% flowering stage and dough seed stage) at 0.40 IW : CPE with one common irrigation for sowing coupled with twice hand weeding at 3 and 6 weeks after sowing.

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# CERTIFICATE

This is to certify that the thesis entitled **"RESPONSE OF DILL SEED (*Anethum graveolens* L.) TO IRRIGATION AND WEED MANAGEMENT PRACTICES UNDER MIDDLE GUJARAT AGRO CLIMATIC CONDITION"** submitted by **PATEL SURESHKUMAR MAGANBHAI (Reg. No. 04-4886-2001)** in partial fulfilment of the requirements for the award of the degree of **DOCTOR OF PHILOSOPHY (AGRICULTURE)** in **AGRONOMY** of the Anand Agricultural University is a record of bonafide research work carried out by him under my personal guidance and supervision and the thesis has not previously formed the basis for award of any degree, diploma or other similar title.

**Place** : Anand
**Date** : October 28th, 2005

**(T. G. Meisheri)** 28/10/05
Major Advisor

# Acknowledgement

**"Gratitude is the most exquisite form of memory"**

Acknowledgement is written at last, placed at first and read the least, but still it is the only opportunity to thank one and all who are responsible in completion of this mite of nine to science.

I express deep sense of reverence to **Dr. T. G. Meisheri**, Retired Professor and Head, Department of Agronomy, B. A. College of Agriculture, Anand Agricultural University, Anand and chairman of my advisory committee for his encouragement and unquantifiable help and his rays of advice, inspiring subtle guidance and scrupulous perusal of manuscript of the thesis. I sincerely and honestly confess that it has been a privilege for me to be his student who stood as a strong support in periods of my distress.

I register my sincere thanks to my advisory committee member Dr. V. R. Bhatt, Minor Advisor, Professor, Dept. of Agril. Chem. & Soil Sci., Dr. R. H. Patel, Associate Professor, Department of Agronomy and Dr. S. K. Dixit, Professor and Head, Dept. of Agril. Statistics, B. A. College of Agriculture, Anand Agricultural University, Anand for their valuable comments and helpful suggestions during the course of this investigation.

I am gratefully indebted to the Joint Director and Inspector General of Police of Gujarat Police Academy, Karai, Gandhinagar for permitting me to continue my Ph. D. study.

I also express my special thanks to Dr. R. B. Patel, Associate Research Scientist, AICRP on weed control, A.A.U., Anand for having spared his valuable time and for his kind help during the experiment.

I am equally grateful to Dr. J. J. Patel, Dr. A. C. Sadhu, Dr. M. V. Patel, Dr. D. A. Tank, Dr. M. I. Meishuria, Dr. J. B. Patel, Prof. N. R. Patel, Prof. V. P. Parekh, Prof. B. G. Patel, Prof. D. S. Chauhan, Shri. K. M. Gediya and Shri. B. D. Patel, Department of Agronomy, B. A. College of Agriculture, Anand Agricultural University, Anand who are responsible for the drop of knowledge I may posses in the ocean of science.

I wish to acknowledge Dr. A. M. Shekh, Principal, B. A. College of Agriculture, Anand for providing facilities during the course of my study.

I also wish to place on record my deep sense of gratitude to Dr. M. R. Patel, Dr. S. T. Patel, Dr. J. S. Patel, Dr. S. K. Patel and Shri. K. P. Patel for their kind help in research work of qualitative nature.

My special thanks are to Prof. G. G. Patel, Farm Manager and other field workers of college Agronomy farm for their cooperation during the period of this investigation.

I offer my special thanks to my uncle Dr. J. G. Patel, Principal, C. P. College of Agriculture, Sardar Krushinagar for their continuous encouragement.

No words in this mortal world can suffice, to express my feelings towards my beloved parents **Divaben** and father **Maganbhai**, my way in this world paves through the path carved out by my parents, whom I wish to idolize through out my life.

I reserve my high appreciation and thanks to my wife Smt. **Laxmi**, daughter **Aryata** and my borther **Piyush** for their patience, personal sacrifices, continued encouragement and keenness during the period of my study.

It is friends indeed who share my secret. It is they who provide crutches to the crumbling house of confidence and forbearance. On this note, I visualize a name which strikes my mind, Pinakin, Vikram, Manhar, Dharmesh, Bhavesh, Umesh, Manish, Jatin, Paresh, Vipul, Rajesh and Sandip who have inspired me and helped me in all respects during this study to whom I remain indebted forever.

Finally, I frankly admit that it is not possible to remember all the faces that stood behind the façade at this juncture and omission of any names does not mean lack of gratitudeness. Now as I carry this thesis in my hand. I carry with me memories that will enrich my nostalgia. I have taken literary license but any factorial errors are my responsibility alone.

S. M. Patel

Place : Anand
Date : October 24th, 2005

**(S. M. Patel)**

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# ⁂ LIST OF ACRONYMS AND SYMBOLS ⁂

| | |
|---|---|
| % | Per cent |
| $^0C$ | Degree Celsius |
| @ | At the rate of |
| a.i. | Active ingredient |
| Anon. | Anonymous |
| C.D. | Critical difference |
| C.V. | Co-efficient of variance |
| CBR | Cost benefit ratio |
| cm | Centimetre |
| CPE | Cumulative Pan Evaporation |
| CU | Consumptive use |
| DAS | Days after sowing |
| dS $m^{-1}$ | Desi Siemens per metre |
| EC | Electrical conductivity |
| *et al.* | et allii ; and co-workers |
| etc. | Etcetera; and rest, so on |
| Fig. | Figure |
| g | Gramme |
| GAU | Gujarat Agricultural University |
| H.I. | Harvest index |
| hr. | Hour |
| HW | Hand weeding |
| I | Irrigation |
| I x W | Interaction between irrigation and weed management treatments |
| i.e. | That is |

| | |
|---|---|
| IW | Irrigation water |
| $K_2O$ | Potassium oxide |
| kg | Kilogram |
| kg $ha^{-1}$-mm | Kilogram per hectare per millimetre |
| km $hr.^{-1}$ | Kilometer per hour |
| l | Litre |
| m | Metre |
| $m^2$ | Square metre |
| Max. | Maximum |
| mg | Milligram |
| Min. | Minimum |
| ml | Mililitre |
| mm | Milimetre |
| MT | Metric tonne |
| N | Nitrogen |
| NS | Not significant |
| O. C. | Organic carbon |
| $P_2O_5$ | Phosphorus pentoxide |
| PE | Pre emergence |
| pH | Potential of hydrogen ion |
| $Plant^{-1}$ | Per plant |
| $Plot^{-1}$ | Per plot |
| S. Em. $\pm$ | Standard error of mean |
| Sig. | Significant |
| WAS | Weeks after sowing |
| WCE | Weed control efficiency |
| WR | Water requirement |
| WUE | Water use efficiency |

# Introduction

# I. INTRODUCTION

Dill seed (*Anethum graveolens* L.) a member of family Apiaceae, is a slender annual or biennial aromatic herb cultivated for its aromatic foliage and fruits used as culinary herb in French, Greek and Oriental cooling all over the world. Dill seed as a green pot herb is very popular in some parts of India where it is generally cooked with Palak (*Spinacea oleracea*). It is also in great demand as a condiment for flavoring pickles, soup and salad for confectionary and also for making tea. Seeds are also put to the same use. The herb contains vitamin C as high as 1.214 mg $g^{-1}$. The oil of dill fruits and its emulsion in water (Dill water) are considered to be aromatic, carminative and effective in colic pains, vomiting and hiccups and possesses anti-pyretic and anthelmenthic properties. The oil from the seeds is known for flatuance in children and used in the preparation of gripe water. The dill herb oil is less important than the dill fruit oil. The dried exhausted fruit (after distillation of essential oils) contains 16.80 to 20.50 per cent of fatty oils. They are rich in protein (14.50 to 16.60 %) and can be used as cattle feed. Dill oil is used in perfumery industry as a replacement of caraway. The oil of Indian dill seed is employed on a large scale in pharmaceutical industry as a substitute for the European Dill. This is because of easy separation of dill apiol in a fractionating column as it is heavier than water and also abundantly available at comparatively low price.

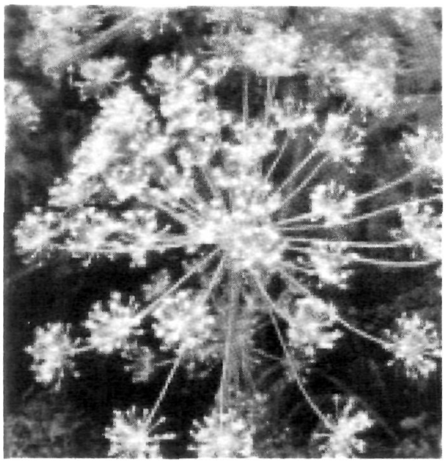
Dill seed is widely grown in Asia, North Africa and in all other tropical countries. In India, it is mostly grown in Maharashtra, Gujarat, Andhra Pradesh, Madhya Pradesh and Rajasthan. But no reliable statistics are available for an area and production of dill seed, yet as reported by the Department of Economics and Statistics, Ministry of Agriculture, Government of India produced about 4963 tones during 1993-94 (Pruthi, 2001). In Gujarat, mostly it is grown in North Gujarat districts such as Mehsana, Sabarkantha, Ahmedabad and now introduced in Surendranagar district of Saurashtra area. It is cultivated in 5790 hectares of land with 5480 tonnes of dill seed production (Aglodia *et al.*, 2005). Productivity of this crop in Gujarat is low (500 kg $ha^{-1}$ under dry and 1500 kg $ha^{-1}$ under irrigated condition) due to lack of proper scientific information regarding its cultivation practices. Thus, there is a considerable scope for increasing the production of this crop in this region by exploiting proper agro-techniques including irrigation and weed management for dill seed crop.

Water management stands second next to fertilizer in augmenting the crop yield. Studies on water management have become an important aspect of research conducted in the field of irrigated crops. Apart from the use of water for successful crop production, there is need for improving its efficiency of utilization in order to achieve a comparatively high rate of production from unit area per unit time and per unit quantity of water used. Among the various approaches advocated for achieving higher water use efficiency, application of irrigation water based on climatological data and at critical crop growth stages helps in the determining the effective use of water and to maintain adequate moisture content to keep the soil in proper structural condition.

Weed growing alongwith crop, use more water and nutrients as compared to the crop plant because they are having good competitive ability given by the nature. Due to slow germination process and slow initial growth rate, weed infestation causes heavy loss of dill seed production required as they compete with the crop plant for moisture, available nutrients, light and space. Weed infestation results in reduction of yield to the extent of 50 to 60 per cent in dill seed (Prajapati *et al.,* 2002). The extent of these losses depends on the crop weed association, the intensity of weed population, the species of weeds, the fertility of soil and several other agroclimatic factors. Dill is also a draught resistant plant, hence weeds growing along with crop used more water and reduce the water available for crop in draught area. Therefore, the control of weeds at proper stages of crop growth is considered very essential for reducing losses and increasing crop production. Singh *et al.* (1995) have published an excellent review on the crop management technique of dill and have concluded that no information is yet available on any herbicides for controlling weeds. Hand weeding and interculturing through effective, there is always regeneration of weeds, which requires frequent operations and this practices have became more costly, time consuming and cumbersome.

Since there is a very scanty research information available on chemical method of weed control and irrigation management in dill seed. In view of the above, the present experiment on "Response of dill seed (*Anethum graveolens* L.) to irrigation and weed management practices under middle Gujarat Agro climatic condition" during *rabi* season of the year 2002-2003 and 2003-2004 at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand was planned with the following objectives :

1) To study the effect of irrigation on growth, yield attributes and yield of dill seed.
2) To find out most suitable irrigation scheduling for dill seed under sandy loam soil.
3) To ascertain comparative performance of herbicides on growth, yield attributes and yields of dill seed and workout most remunerative method of weed control.
4) To identify effective herbicides for controlling weeds in dill seed.
5) To find out phytotoxic effect of herbicides on crop if any.
6) To find out interactive effect of irrigation and weed management practices on growth and yield of dill seed.



# Review of Literature

# II. REVIEW OF LITERATURE

A comprehensive review of literature is an essential part of any scientific investigation. In this chapter, a brief review of studies carried out at several places, more or less related to the present investigation is cited. The review has been highlighted, compiled and reviewed briefly under the following heads.

2.1 Effect of irrigation on growth, yield attributes, yield and quality of spices crop

2.2 Effect of weed management practices

2.2.1 Effect of weed management practices on weeds in spices

2.2.2 Effect of weed management practices on yield of spices

2.3 Interaction effect of irrigation and weed management practices on crops

## 2.1 EFFECT OF IRRIGATION ON GROWTH, YIELD ATTRIBUTES, YIELD AND QUALITY OF SPICES CROP

Water governs most of the metabolic and physiological processes responsible for growth and development of any plant. Irrigation plays a key role in this context. Reports on studies on irrigation in dill seed are not available, hence efforts are made to give past review on related spices crops *viz.,* cumin (*Cuminum cyminum* L.) coriander (*Coriandrum sativum* L.) and fennel (*Foeniculum vulgara* P. Miller) irrespective to approach used for scheduling irrigation.

Lal (1969), while working at Government Research Station, Kaliyanpur (U.P) reported that a light irrigation just after sowing in cumin hastens the rate of germination. He further suggested that if the temperature is too low and the soil is not too fine, give second irrigation at 8-10 days after sowing to ensure good germination. After germination, the crop should be irrigated at 15 days interval. Similar recommendation was also made by Chandola *et al.* (1970) and Sharma and Agarwal (1978).

A field experiment was planned on the basis of soil moisture deficient approach (100 to 30% available soil moisture) on sandy loam soil at the Irrigation Research and Demonstration Farm, Pilwai during *rabi* season of 1958 to 1968 to study the water requirement of cumin crop. From the results of this experiment, Joshi (1971-72) reported optimum seed yield in cumin with 5 irrigations.

Wedleigh (1975) observed that plant growth steadily decreased with increasing soil moisture tension from near saturation to the wilting point.

Mann (1980) suggested single irrigation after sowing for germination and thereafter irrigation at an interval of 12 to 20 days depending upon weather and soil conditions. He also suggested flowering and seed formation stages as critical stages for irrigation in cumin.

An experiment was conducted at the Agronomy Farm of Shri Karan Narendra College of Agriculture, Jobner during the *Rabi* season of 1979-80 to study the effect of different levels of irrigation, nitrogen and method of weed control on growth, yield and quality of cumin. From the results of this experiment, Tanwar (1982) recorded that the application of irrigation at IW : CPE ratio of 0.60 or 83 mm CPE produced significantly higher plant height, number of branches, umbels, umbellates, dry matter, seed and straw weight plant$^{-1}$, test weight, seed yield (39.18 percent), nitrogen per cent and protein content in seed and straw.

An experiment was conducted during the *rabi* season of 1979-80, 1980-81 and 1982-83 on cumin crop to find out the water management practices under heavy black soil at Water Management Research Project, Gujarat Agricultural University, Navsari (South Gujarat) with six treatment combinations comprising of two depths of irrigation ($I_1$-50 mm and $I_2$-70 mm) and three levels of irrigations based on IW : CPE ratios ($R_1$-0.40, $R_2$–0.55 and $R_3$–0.70). It was found that treatment combination $I_2R_3$ (70 mm of irrigation water at IW : CPE ratio of 0.70) gave the highest net profit (RS.

5776 ha$^{-1}$) with the highest water use efficiency of 3.90 kg ha$^{-1}$-mm, (Anon., 1983).

Hornok and Csaki (1987) showed that yield of dill seed and coriander increased with irrigation but yield of dill seed decreased. They also reported that irrigation had no effect on volatile oil contents of spices.

Patel *et al.* (1988) reported that to get higher grain yield, net profit and water use efficiency, application of 60 mm irrigation water at IW : CPE ratio of 0.90 was found to be optimum and economical for growing fennel crop in heavy black soil of South Gujarat region. This treatment required nine irrigations at an interval of 15 to 20 days.

A field experiment was conducted on medium black soil of Instructional Farm, Gujarat Agricultural University, Junagadh during *rabi* season of 1988-89 in order to study the response of cumin to irrigation, nitrogen and phosphorus. From the results of experiment, Patel (1989) reported that the application of irrigation at IW : CPE ratio of 0.60 remarkably increased plant spread at 60 DAS and at harvest number of branches plant$^{-1}$, number of umbels plant$^{-1}$, number of umbellates umbel$^{-1}$, number of seeds umbellate$^{-1}$ and weight of seed plant$^{-1}$. IW : CPE ratio of 0.60 gave significantly higher seed and stover yield then the rest of the ratios and also recorded maximum net profit.

Modi (1990) conducted an experiment on loamy sand soil of North Gujarat during *rabi* season in order to study the response of dill seed to irrigation schedules based on IW : CPE ratio (0.40, 0.60, 0.80, 1.00 and 1.20) and nitrogen levels. Results revealed that irrigating the crop at an IW : CPE ratio of 0.60 recorded maximum seed yield, water use efficiency, number of umbels plant$^{-1}$, number of umbellates umbel$^{-1}$ and number of seeds umbel$^{-1}$. He also observed that irrigation schedule did not exert significant influence on oil content.

At Indian Agricultural Research Institute, New Delhi, Sharma and Prasad (1990) reported that irrigating the *rabi* fennel at an IW : CPE ratio of 0.60 resulted in higher seed yield but it was found at par with an IW :CPE ratio of 0.80. Patel *et al.* (1992) also reported higher seed and stover yield of cumin in 0.60 IW : CPE ratio as compared to 0.45 and 0.30 IW : CPE ratio at Junagadh (Gujarat) grown on medium black soil.

Buntain and Chung (1994) observed that application of irrigation increased the dry matter of fennel crop under the prevailing climatic conditions of Australia. Full irrigation and irrigation applied during flowering and late flowering stage increased the number of umbels and oil yield. The best economic return was achieved by irrigating the crop at late flowering stage.

At Jagudan (Gujarat), an experiment was carried out on fennel during *rabi* season of 1994-95 on loamy soil to study the effect of irrigation schedules (0.60, 0.80 and 1.00 IW : CPE ratios) and levels of nitrogen and phosphorous.The results showed that irrigating the crop at an IW : CPE ratio of 1.00 recorded significantly higher seed yield than under lower IW : CPE ratios (Anon., 1995).

A field study was taken during winter season by Jangir and Singh (1996) at Mandor to determine suitable irrigation schedule and optimum dose of nitrogen for cumin on Alfisols. They reported that application of 5 irrigations at sowing, 10, 30, 55 and 80 days after sowing produced significantly higher seed yield than 4 irrigations during the years 1989-90 and 1990-91.

Amin (1999) conducted an experiment on loamy sand soil of Sardar Krushinagar during *rabi* season of 1994-95 and 1995-96 to study the response of fennel to irrigation level based on IW : CPE ratios (0.60, 0.80 and 1.00) under varying levels of nitrogen and phosphorus. Experimental results showed that all the growth characters *viz.,* plant height, number of primary, secondary and tertiary branches plant$^{-1}$ and yield attributes *viz.,* number of umbels plant$^{-1}$, number of umbellates umbel$^{-1}$, number of seeds umbellate$^{-1}$ and test weight plant$^{-1}$ were enhanced with increasing in IW : CPE ratio from 0.60 to 1.00. Maximum seed yield was recorded with IW : CPE ratio of 1.00 closely followed by IW : CPE ratio of 0.80, but these both treatment gave significantly higher seed yield than that of recorded with an IW : CPE ratio of 0.60.

Patel *et al.* (2000) conducted an experiment during winter season of 1994-1995 with fennel variety of "GF-1" on sandy loam soil. Experimental results showed that potential production and profit could be obtained by scheduling irrigation at an IW : CPE ratio of 1.00.

Amin and Patel (2001) studied influence of irrigation on yield and quality of *rabi* fennel grown on loamy sand soil of Sardar Krushinagar, whereas three different rates of irrigation (0.60, 0.80 and 1.00 IW : CPE ratio) applied. The seed and stover yields and oil content of fennel increased with increased in IW : CPE ratio from 0.60 to 1.00.

Joshi (2002) conducted an experiment on loamy sand soil of North Gujarat during *rabi* season in order to study the response of drilled rabi fennel to irrigation schedules based on IW : CPE ratios (0.60, 0.75, 0.90 and 1.05) and nitrogen levels. Results revealed that irrigating the crop at IW : CPE ratios of 0.90 and 1.05 recorded at par and significantly higher seed yield, water use efficiency, number of umbels plant$^{-1}$, number of umbellates umbel$^{-1}$, number of seeds umbel$^{-1}$, stover yield then that observed under rest of IW : CPE ratio. Consumptive use of water increased with each successive increased in levels of IW : CPE ratio.

A field trial was conducted during 1997-1999 at New Delhi, to study growth, seed yield and water use by fennel under various levels of irrigation. Application of 3 irrigation at branching, flowering and seed filling stages, being at par with 2 irrigation at branching and seed feeling stages, was superior to the remaining irrigation levels for growth attributes and seed yield. Further noted that increase in number of irrigation from 2 to 3 decreased the water use efficiency and maximum water use efficiency was recorded with no irrigation treatment. (Kumar *et al.,* 2002).

A study was conducted at Mandor, Rajasthan to determine the effect of irrigation on growth and yield of cumin. It was observed that irrigation schedule of 4 irrigations resulted in significantly higher seed yield (889 kg $ha^{-1}$) of cumin over 3 irrigations (Yadav and Dahama, 2003) and further they recorded that both the irrigation scheduling of 3 or 4 irrigation did not affect the dry weight of weeds during both the years.

The field experiment was conducted during the winter season of 2001-02 on sandy loam soil at Sriganganar, Rajasthan, to study the water use, nutrient uptake, yield and economics of fennel. Bhunia *et al.* (2005) reported that increase in irrigation frequency from IW : CPE ratio 0.4 to 0.8, yield and most of the yield attributes increased significantly. Similarly, they also reported that water use and nutrient uptake were higher with higher levels of irrigations.

## 2.2 EFFECT OF WEED MANAGEMENT PRACTICES

It is well established that weeds cause tremendous yield losses in various crops. Such losses occur mainly due to competition between crops and weeds for light, water, space and nutrients. Per cent yield losses widely among field crops under different agro-climatic conditions and management options. Therefore, it becomes essential to keep the weeds controlled in order to optimize the yield. The available information pertinent to the present investigation is reviewed as under:

### 2.2.1 Effect of weed management practices on weeds in spices

Pandey and Singh (1977) conducted field experiment on sandy loam soil at IGFRI, Jhansi to study the effect of chemical weed control in coriander. They reported that pre emergence application of prometryne at 2 kg $ha^{-1}$ gave highest degree of weed control which reduced 97.4 percent of weeds by number and 96.5 percent of weeds by weight followed by pre planting application of trifluralin at 2 kg $ha^{-1}$, pre emergence application of prometryne at 1 kg $ha^{-1}$ and pre-plant application of trifluralin at 1 kg $ha^{-1}$ which reduced the weed population by 93, 88 and 85 percent, respectively over no weeding.

Mehta *et al.* (1985) at Anand, found two hand weeding superior for weed control over isoproturan and oxyfluorfen in cumin.

Singh (1986) carried out an experiment at Jobner under loamy sand soil condition and observed that for control of weeds in cumin, application of pendimethalin @ 1.0 kg $ha^{-1}$ as pre emergence found at par with 0.5 kg $ha^{-1}$ as pre-emergence of terbutryne, 1.0 kg $ha^{-1}$ as oxadiazon and 1.0 kg $ha^{-1}$ as pre plant incorporation of fluchloralin.

Raghvani *et al.* (1987) studied the chemical weed control in cumin at Junagadh on medium black soil. The treatments consisted of fluchloralin 0.9 kg $ha^{-1}$ as pre plant and pre emergence, nitrofen 2.0 kg $ha^{-1}$ as pre plant and post emergence, oxadiazon 1.0 kg $ha^{-1}$ as pre emergence and benthiocarb 2.0 kg $ha^{-1}$ as pre emergence, oxyfluorfen 0.48 kg $ha^{-1}$ as pre emergence, methabenzthiozuron 1.4 kg $ha^{-1}$ as pre emergence and weed free. The results revealed that though fluchloralin 0.9 kg $ha^{-1}$ as pre and post emergence, oxadiazon 1.0 kg $ha^{-1}$ as pre emergence, benthiocarb 2.0 kg $ha^{-1}$ as pre emergence and oxyfluorfen 0.48 kg $ha^{-1}$ as pre emergence were effective in weed control. Oxadiazon 1.0 kg $ha^{-1}$ as pre emergence was found most economical and best effective herbicide for weed management in cumin.

Kothari *et al.* (1989) studied the chemical weed control in coriander on clay loam soils of Pantanagar, wherein three rates of oxadiazon (0.25, 0.50 and 0.75 kg $ha^{-1}$) as pre emergence, fluchloralin (0.50, 0.75 and 1.0 kg $ha^{-1}$) as pre plant, pendimethalin (0.25, 0.50 and 0.75

kg ha$^{-1}$) as pre plant and propanil (1.5, 2.0 and 2.5 kg ha$^{-1}$) as post emergence along with three additional treatment of weed free, weedy check and two hand weedings (35 and 60 DAS) were tried. Application of pendimethalin and fluchloralin at 0.75 and 1.0 kg ha$^{-1}$ showed 76.5 and 71.9 per cent weed control efficiency, respectively. Further, they observed that application of oxadiazon at 0.25–0.75 kg ha$^{-1}$ provided weed free conditions for a limited period only and thus it failed to control the weed species, which germinated at later stage of crop growth. Propanil at 1.5-2.5 kg ha$^{-1}$ failed to control certain broad leaf weeds.

Patel and Mehta (1989) studied the integrated weed management practices in cumin on loamy sand soil of Anand, wherein three different rates each of pendimethalin (0.5, 1.0 and 1.5 kg ha$^{-1}$) fluchloralin and thiobencarb (both at 0.5, 0.75 and 1.0 kg ha$^{-1}$) applied as pre emergence in addition to these their lower rates integrated with hand weeding and hoeing were compared. Authors reported that application of pendimethalin @ 0.5 kg ha$^{-1}$ with integration of one hand weeding suppressed the weed population to the tune of 95 per cent. Similarly, application of fluchloralin @ 0.5 and 0.75 kg ha$^{-1}$ with one hand weeding were also found effective in controlling weeds and weed control efficiency of 86 and 93 per cent, respectively.

An experiment was conducted during 1982-83 and 1983-84 at Jobner to study the effect of nitrogen and weed control measures on weeds and cumin by Chaudhary and Gupta (1991). Hand weeding gave the lowest dry weight of weed at all the growth stages of the crop.

Mitchell *et al.* (1994) evaluated four herbicides viz., pendimethalin (1.0 kg $ha^{-1}$), linuron (0.75 kg $ha^{-1}$), prometryne (1.0 kg $ha^{-1}$) as pre emergence and paraquat (0.5 kg $ha^{-1}$) as post emergence for control of weeds in coriander on silt loam soil. Pendimethalin was found to be most effective herbicide in the control of weeds in coriander crop.

Gora *et al.* (1996) conducted experiment to study the dry matter accumulation and nitrogen uptake as affected by weed control measures and time of nitrogen application in Cumin at Jobner during 1991-92. They reported that hand weeding twice at 20 and 50 days after sowing caused significant reduction in dry matter of weeds and N uptake, but the application of oxyfluorfen @ 0.15 and 0.30 kg $ha^{-1}$ had significantly lowest dry matter accumulation and N uptake by weeds as compared to rest of the treatments.

In a field experiment conducted on sandy clay loan soil at Coimbature, Pradeep and Sundarum (1996) observed that two hand weedings was the most effective method of weed control in coriander. It was followed by the treatment involving one hand weeding integrated with pendimethalin 1.0 kg ha$^{-1}$ as pre emergence.

An experiment was conducted at Jabalpur on coriander to study the effect of different herbicides and their relative efficiency on weed control (Anon., 1998). It was observed that most of the broad leaf weeds and weed biomass were effectively controlled by oxadiazon, oxyfluorfen and pendimethalin. The results further revealed that the highest weed control efficacy was recorded under oxyfluorfen (57.0%) followed by oxadiazon (50.1%) and pendimethalin (46.5%).

Senthivel *et al.* (1999) carried out the investigation at Aruppukottai, Tamil Nadu on medium clay soil with four herbicides *viz.,* butachlor, fluchloralin pendimethalin and thiobencarb each in two concentrations at 0.5 and 1.0 kg ha$^{-1}$ and two methods of application *viz.,* pre sowing soil incorporation and pre emergence. Application of butachlor @ 1.0 kg ha$^{-1}$ applied as pre sowing soil incorporation followed by one hand weeding at 40 DAS was found to be an ideal and economical method of weed control in coriander.

An experiment was conducted at Kanpur on coriander to test the efficacy of four herbicides *viz.,* pendimethalin (1.0 kg ha$^{-1}$), oxyfluorfen (0.10 kg ha$^{-1}$), pretilachlor and metolachlor (both at 1.5 kg ha$^{-1}$). These herbicides were compared with unweeded and manual weeding. The results indicated that among the herbicides, pendimethalin (1.0 kg $ha^{-1}$) was the most effective and gave lowest weed dry weight (Anon, 2000).

Kumar (2002) at Jalore, Rajsthan conducted an experiment in 1996-97 and 1997-98 in order to study the weed management in cumin. The results indicated that pendimethalin 1.0 kg $ha^{-1}$ (PE) and 2 hand weedings at 25 and 45 days after sowing caused least weed counts and dry weight of weeds and recorded higher cost benefit ratio over weed free check.

Dungarwal *et al.* (2003) reported that planting incorporation of fluchloralin and pre emergence of pendimethalin, trifluralin and linuron significantly reduced weed density and weed dry matter as compared to weedy check.

Application of fluchloralin at 1.0 kg $ha^{-1}$ as pre plant incorporation significantly reduced the dry weight of weed in cumin compared to weed check treatment during 1996-1997 and 1997-1998 (Yadav and Dahama, 2003).

Patel *et al.* (2004) carried out an experiment at Anand to find out effective and efficient weed management practices in coriander. Application of oxadiazon @ 0.5 kg $ha^{-1}$ was the most effective in controlling weeds which enhanced growth and yield of coriander.

A field study was conducted during the winter season of *rabi* 2000-01 and 2001-02 at S. K. N. College of Agriculture, Jobner (Rajasthan) on loamy sand soil to investigate the comparative efficacy of herbicides and manual weed control in cumin at different levels of nitrogen. Two hand weeding at 25 and 50 days after sowing was found to be the best treatment in reducing the weed parameters. It attained the maximum weed control efficiency (87.9 %) of cumin and as a result of which this treatment also recorded the lowest depletion of nutrients by weed. It saved the maximum quantity of 42.39 kg N and 6.39 kg $P_2O_5$ $ha^{-1}$ up to harvest as compared to weedy check. Among herbicides, pendimethalin at 1.0 kg $ha^{-1}$ and fluchloralin at 1.125 kg $ha^{-1}$ controlled the weeds effectively to the extent of 79.3 and 75.9 %, respectively (Yadav *et al.*, 2005).

### 2.2.2 Effect of weed management practices on yield of spices

Pandey and Singh (1977) reported that pre planting application of trifluralin (1.0 kg $ha^{-1}$) and pre emergence of prometryne (1and 2 kg $ha^{-1}$) promoted crop yield of coriander substantially and were found to be statistically superior over weedy check.

From the results of a field trial conducted at Ukrainian, Tkachenko (1979) observed that propanil applied @ 5-6 kg $ha^{-1}$ as pre emergence considerably increased the seed yield of coriander.

Tanwar (1982), from the result of a trial on effect of methods of weed control on growth, yield and quality of cumin at Jobner, concluded that mechanical method of weed control significantly increased crop growth, yield attributes and the seed yield.

The findings of Raghvani *et al.* (1985) indicated that pre emergence application of oxadiazon 0.75 kg $ha^{-1}$ produced higher grain yield of coriander with highest net return and weed control efficiency at Junagadh, Gujarat.

In the experiment at Jobner, Singh (1986) observed that pendimethalin at 1.0 kg $ha^{-1}$ applied as pre emergence gave significant higher yield over 0.5 kg $ha^{-1}$ and at par with two and three hand weedings as well as 1.0 kg $ha^{-1}$ of fluchloralin applied as pre plant incorporation.

Raghvani *et al.* (1987) evaluated six herbicides *viz.,* fluchloralin nitrofen, methabenzthiozuron, oxadiazon, benthiocarb and oxyfluorfen along with weed free and unweeded check in cumin crop grown on medium black soil of Junagadh. They observed that among the herbicides, oxadiazon @ 1.0 kg $ha^{-1}$ recorded higher grain yield of crop and recorded the highest net return.

Kothari *et al.* (1989) from Pantnager observed that the application of pendimethalin at 0.75 kg $ha^{-1}$ and fluchloralin at 1.0 kg $ha^{-1}$ as pre plant and weed free check produced significantly higher yield attributes and yield of coriander than other herbicidal treatments and conventional methods of two hand weedings.

On loamy sand soils of Anand, Patel and Mehta (1989) observed that pendimethalin @ 0.5 kg $ha^{-1}$ gave maximum seed yield of cumin with highest net ICBR as compared to other herbicides.

From the results of field trial conducted at Jobner, Chaudhary and Gupta (1991) concluded that hand weeding showed the highest values of yield attributes and seed yield, followed by pre emergence application of terbutryn @ 1.0 kg $ha^{-1}$. However, herbicidal treatment showed higher benefit cost ratio than hand weeding.

Mitchell *et al.* (1994) reported that pendimethalin applied @ 1.5 kg $ha^{-1}$ had the least effect on coriander population and vigour and gave effective weed control in the coriander crop.

Field experiment was conducted by Barevadia *et al.* (1995) on loamy sand soils of Anand in order to evaluate the relative performance of different eight herbicides *viz.,* alachlor, metolachlor, thiobencarb, fluchloralin, pendimethalin, isoproturon and oxadiazon each @ 1.0 kg $ha^{-1}$ and oxyfluorfen @ 0.1 kg $ha^{-1}$ for the control of weeds in coriander crop. They observed that application of oxadiazon at the rate of 1.0 kg $ha^{-1}$ recorded the highest seed yield of coriander followed by pendimethalin, metolachlor and fluchloralin each at 1.0 kg $ha^{-1}$, which remained at par in their effect on increasing the yield.

Gora *et al.* (1996) reported that the yield attributes characters, seed and straw yield of cumin were superior under hand weeding at 20 and 50 DAS but the test weight remained unchanged due to weed management practices in cumin.

Results of the field experiment conducted at Jabalpur showed that hand weeding significantly increased the seed yield of coriander over other weed control treatments followed by oxadiazon, pendimethalin and oxyfluorfen and these were statistically at par with each other (Anon, 1998).

The results of field experiment conducted at Kanpur revealed that the maximum seed yield of coriander was obtained under the application of pendimethalin 1.0 kg $ha^{-1}$ (Anon., 2000).

Kumar (2001) reported that cumin seed yield increased significantly with the increasing in initial duration of weed free condition and also found critical period of weed free condition to 22-39 days after showing.

While studying the effect of different herbicides on weed control in coriander, Senthivel (2001) concluded that among the herbicides, pendimethalin performed well in controlling weeds and seed yield obtained higher under 1.0 kg $ha^{-1}$ as compared to 0.5 kg $ha^{-1}$.

Kumar (2002) carried out an experiment on weed management in cumin on silty loam soil at Jalore (Rajasthan). He observed that application of Pendimethalin @ 1.0 kg $ha^{-1}$ resulted into higher yield which was at par with weed free treatment.

An experiment was conducted at Sumerpur, Rajasthan on the sandy loam soil on cumin to test the efficacy of four herbicides viz., fluchloralin (1.0 kg $ha^{-1}$), pendimethalin (1.0 kg $ha^{-1}$), trifluralin (1.0 kg $ha^{-1}$) and linuron (0.5 kg $ha^{-1}$). These herbicides were compared with weedy condition. The result indicated that all the weed control treatments brought about significant improvement in yield attributes and yield except test weight of cumin. Application of these herbicides were found to be non significant on the test weight of cumin (Dungarwal *et al.*, 2003).

Patel *et al.* (2004) observed significantly higher coriander yield (2599 kg $ha^{-1}$) in oxadiazon @ 0.5 kg $ha^{-1}$ treatment, which was at par with application of pendimethalin @ 0.75 kg $ha^{-1}$ at Anand.

Patel *et al.* (2005) studied chemical weed control in pearl millet cropping system at Anand. An experiment was carried out on sandy loam soil. Results revealed that application of pendimethalin @ 1.0 kg $ha^{-1}$ or fluchloralin @ 1.0 kg $ha^{-1}$ or trifluralin @ 1.0 kg $ha^{-1}$ was equally effective to control weeds in cumin, whereas in cumin-pearlmillet cropping system, only trifluralin @ 1.0 kg $ha^{-1}$ was effective without showing residual effect on succeeding pearlmillet.

A field study was conducted during the winter season of *rabi* 2000-01and 2001-02 at S. K. N. College of Agriculture, Jobner (Rajasthan) on loamy sand soil to investigate the comparative efficacy of herbicides and manual weed control in cumin at different levels of nitrogen. Two hand weeding at 25 and 50 days after sowing was found to be the best treatment in increasing the seed yield (550 kg $ha^{-1}$) of cumin. Among herbicides, pendimethalin at 1.0 kg $ha^{-1}$ and fluchloralin at 1.125 kg $ha^{-1}$ yielded cumin seed 439 and 454 kg $ha^{-1}$, respectively (Yadav *et al.*, 2005).

## 2.3 INTERACTION EFFECT OF IRRIGATION AND WEED MANAGEMENT PRACTICES ON CROPS

Scanty work has been done on interactive effect of irrigation and weed management practices in spices crops. Therefore, review of *rabi* crops have been presented here.

Patel and Mehta (1990) during the *Rabi* season of the year 1985-86 at the College Agronomy Farm, GAU, Anand on loamy sand soil conducted an experiment to investigate the effect of irrigation timing and isoproturon application on weeds and yield of Isabgul. Among various interactions, the combination of irrigation immediately after sowing with hand weeding at 20 DAS significantly increased seed yield but considering the cost of hand weeding, herbicide was conducive. The treatment combinations irrigation at sowing and isoproturon @ 0.5 kg $ha^{-1}$ and irrigation at 10 DAS and isoproturon @ 0.5 kg $ha^{-1}$ were found beneficial both from yield and management point of view.

Choubey *et al.* (1998) carried out a field experiment on sandy loam soil at Khargpur on wheat (cv. sonalika) and observed that the wheat yield substantially improved with adoption of an irrigation level of 0.8 IW : CPE ratio associated with hand weeding or chemical control of weeds.

Singh *et al.* (2002) studied the effect of irrigation and pendimethalin on growth and seed yield of coriander at Hisar during 1999-2000. They observed that all the growth and yield parameters increase significantly with the increase in irrigation intensity, highest obtained by applying irrigation at 30, 60, 90 and 120 days after sowing. Regarding weed control treatments, maximum yield was obtained under weed free treatment and the lowest under weedy check. No significant differences were observed between pendimethalin 1.0 and 1.5 kg $ha^{-1}$ for yield and most of the growth parameters.

# Materials and Methods

# III. MATERIAL AND METHODS

The details of materials used and the techniques adopted during the course of this investigation are described in this chapter.

## 3.1 EXPERIMENTAL SITE

The present investigation was carried out during the *Rabi* season of the year 2002-2003 and 2003-2004 at the Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand.

## 3.2 CLIMATE AND WEATHER

Geographically, Anand is situated at $22^0$–35' N Latitude, $72^0$–55' E longitude with an elevation of 45.1 m above the mean sea level. It is about 90 km away from Arabian sea coast and hence this region enjoys a typical subtropical climate. Monsoon commences by the third week of June and retreats by the middle of September with average rainfall of 853.2 mm receiving 94 percent in 37 rainy days in four months (June–September). Monsoon is erratic with irregular and insufficient rainfall in this region.

Partial failure of rains once in three to four years is a very common feature of this region. Winter rains and summer storms are normally absent except in some exceptional years. Winter is severe and sets in the month of November and continues till the middle of February. December and January are the coldest months of the year. The average temperature during the winter varies from $11^0$C to $28^0$C. The summer season usually commences during the second fortnight of February and ends by the end of June. April and May are the hottest months with the temperature rising as high as $43^0$ C. Monthly average wind velocity varies from 1.9 to 7.5 km $hr^{-1}$ with an average annual wind speed of 4.3 km $hr^{-1}$. The relative humidity is low during March, April and May.

The observations of the meteorological parameters for the period of investigation during 2002-03 and 2003-04 recorded at the Agrometeorological observatory of the AAU, Anand are presented in Table 3.1 and graphically illustrated in Fig. 3.1 and 3.2, respectively. The minimum temperature ranged between 11.00 $^0$C to 22.27 $^0$C and 9.94$^0$C to 23.37$^0$C during the year 2002-03 and 2003-04, respectively while mean maximum temperature ranged between 26.17$^0$C to 40.49$^0$C and 26.34$^0$ C to 41.43$^0$C during crop season of 2002-03 and 2003-04, respectively. The other weather parameters viz., relative humidity, wind velocity, daily water evaporation and sunshine hours were normal during both the years. In general, the weather conditions were showed normal trend during the crop season.

## 3.3 SOIL CHARACTERISTICS

The soil is representative of the soils of the region and locally known as "*Goradu*" soil. The texture of the soil is sandy loam. The soil is alluvial by their nature of origin, very deep, well drained and fairly moisture retaintion.

**Table 3.1 : Meteorological data recorded during crop seasons of the year 2002-03 and 2003-2004 (Weekly mean)**

| Month | Standard weeks | Dates | Temperature ($^0C$) Maximum Temp. (°C) | | Minimum Temp. (°C) | | Average relative humidity (%) | | Sunshine (hours $day^{-1}$) | | Wind velocity (km $hr^{-1}$) | | Pan water evaporation (mm $day^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2002-03 | 2003-04 | 2002-03 | 2003-04 | 2002-03 | 2003-04 | 2002-03 | 2003-04 | 2002-03 | 2003-04 | 2002-03 | 2003-04 |
| October | 43 | 22-28 | 36.37 | 35.21 | 17.60 | 16.14 | 48.90 | 56.73 | 9.66 | 9.71 | 1.86 | 1.19 | 5.51 | 5.41 |
| | 44 | 29-04 | 36.17 | 35.34 | 16.16 | 19.31 | 54.12 | 57.94 | 9.46 | 9.91 | 1.24 | 2.10 | 4.37 | 5.46 |
| November | 45 | 05-11 | 34.29 | 35.23 | 16.91 | 19.70 | 51.71 | 58.71 | 8.07 | 9.56 | 1.87 | 1.50 | 4.69 | 4.77 |
| | 46 | 12-18 | 32.76 | 33.37 | 14.59 | 16.59 | 53.85 | 59.51 | 9.21 | 9.44 | 2.20 | 1.23 | 4.71 | 4.69 |
| | 47 | 19-25 | 34.63 | 32.33 | 13.96 | 18.01 | 54.86 | 58.96 | 9.79 | 8.53 | 1.30 | 1.73 | 4.34 | 4.49 |
| | 48 | 26-02 | 32.11 | 32.14 | 11.54 | 16.40 | 49.24 | 59.40 | 9.10 | 9.34 | 1.44 | 1.43 | 4.31 | 3.83 |
| December | 49 | 03-09 | 32.06 | 32.50 | 12.71 | 13.40 | 50.67 | 62.14 | 8.96 | 9.36 | 1.61 | 0.99 | 4.01 | 3.71 |
| | 50 | 10-16 | 32.06 | 30.87 | 12.20 | 14.46 | 56.01 | 58.91 | 9.37 | 8.91 | 1.26 | 1.71 | 3.37 | 3.50 |
| | 51 | 17-23 | 31.87 | 26.90 | 13.03 | 11.63 | 54.61 | 61.18 | 9.23 | 9.21 | 1.06 | 2.99 | 3.29 | 3.33 |
| | 52 | 24-31 | 28.05 | 26.34 | 10.90 | 10.61 | 61.20 | 59.08 | 9.00 | 8.88 | 2.30 | 2.35 | 3.56 | 3.51 |
| January | 1 | 01-07 | 26.17 | 28.61 | 12.60 | 11.91 | 55.16 | 49.20 | 8.44 | 8.66 | 4.07 | 2.21 | 4.11 | 3.37 |
| | 2 | 08-14 | 27.80 | 29.67 | 13.79 | 12.37 | 44.76 | 54.54 | 8.90 | 9.33 | 3.83 | 2.43 | 4.46 | 3.69 |
| | 3 | 15-21 | 29.29 | 26.97 | 11.00 | 11.13 | 42.18 | 59.67 | 9.67 | 9.01 | 2.66 | 2.53 | 4.31 | 3.20 |
| | 4 | 22-28 | 30.69 | 26.46 | 11.79 | 9.94 | 56.69 | 62.07 | 9.37 | 9.34 | 1.83 | 2.87 | 4.11 | 3.77 |
| | 5 | 29-04 | 28.54 | 27.01 | 14.09 | 9.94 | 61.40 | 46.43 | 9.26 | 9.67 | 3.86 | 3.36 | 4.63 | 4.90 |
| February | 6 | 05-11 | 30.29 | 28.13 | 12.63 | 10.21 | 54.07 | 55.30 | 9.76 | 9.27 | 2.89 | 4.10 | 4.67 | 5.50 |
| | 7 | 12-18 | 31.74 | 30.49 | 13.44 | 13.50 | 51.35 | 62.35 | 9.26 | 10.01 | 2.89 | 3.67 | 5.30 | 5.86 |
| | 8 | 19-25 | 30.20 | 33.19 | 15.83 | 14.36 | 57.67 | 64.83 | 10.16 | 10.17 | 3.34 | 2.69 | 4.99 | 5.81 |
| | 9 | 26-04 | 33.49 | 33.84 | 16.73 | 15.36 | 50.13 | 46.04 | 10.01 | 9.96 | 3.86 | 3.21 | 6.81 | 6.40 |
| March | 10 | 05-11 | 33.36 | 34.17 | 12.86 | 16.60 | 30.09 | 46.92 | 10.06 | 9.51 | 3.23 | 2.69 | 7.36 | 6.61 |
| | 11 | 12-18 | 35.70 | 34.73 | 15.66 | 18.57 | 39.70 | 44.55 | 9.63 | 5.83 | 2.71 | 2.87 | 7.09 | 6.00 |
| | 12 | 19-25 | 37.13 | 38.91 | 19.09 | 18.79 | 43.70 | 42.40 | 10.13 | 9.74 | 2.94 | 3.36 | 7.69 | 8.33 |
| | 13 | 26-01 | 38.51 | 38.54 | 21.53 | 18.23 | 39.06 | 44.06 | 9.69 | 10.23 | 4.53 | 2.80 | 9.99 | 7.54 |
| April | 14 | 02-08 | 37.97 | 39.03 | 22.27 | 23.37 | 48.33 | 54.41 | 9.74 | 9.36 | 4.47 | 3.63 | 8.11 | 7.67 |
| | 15 | 09-15 | 39.13 | 38.77 | 21.99 | 21.69 | 40.06 | 39.05 | 9.51 | 10.54 | 4.13 | 4.06 | 7.86 | 8.99 |
| | 16 | 16-22 | 38.57 | 39.76 | 21.47 | 23.36 | 50.59 | 39.42 | 9.90 | 9.87 | 4.11 | 4.44 | 8.79 | 9.01 |
| | 17 | 23-29 | 40.49 | 41.43 | 21.43 | 22.51 | 48.20 | 38.27 | 10.60 | 10.36 | 2.80 | 4.54 | 9.97 | 10.51 |

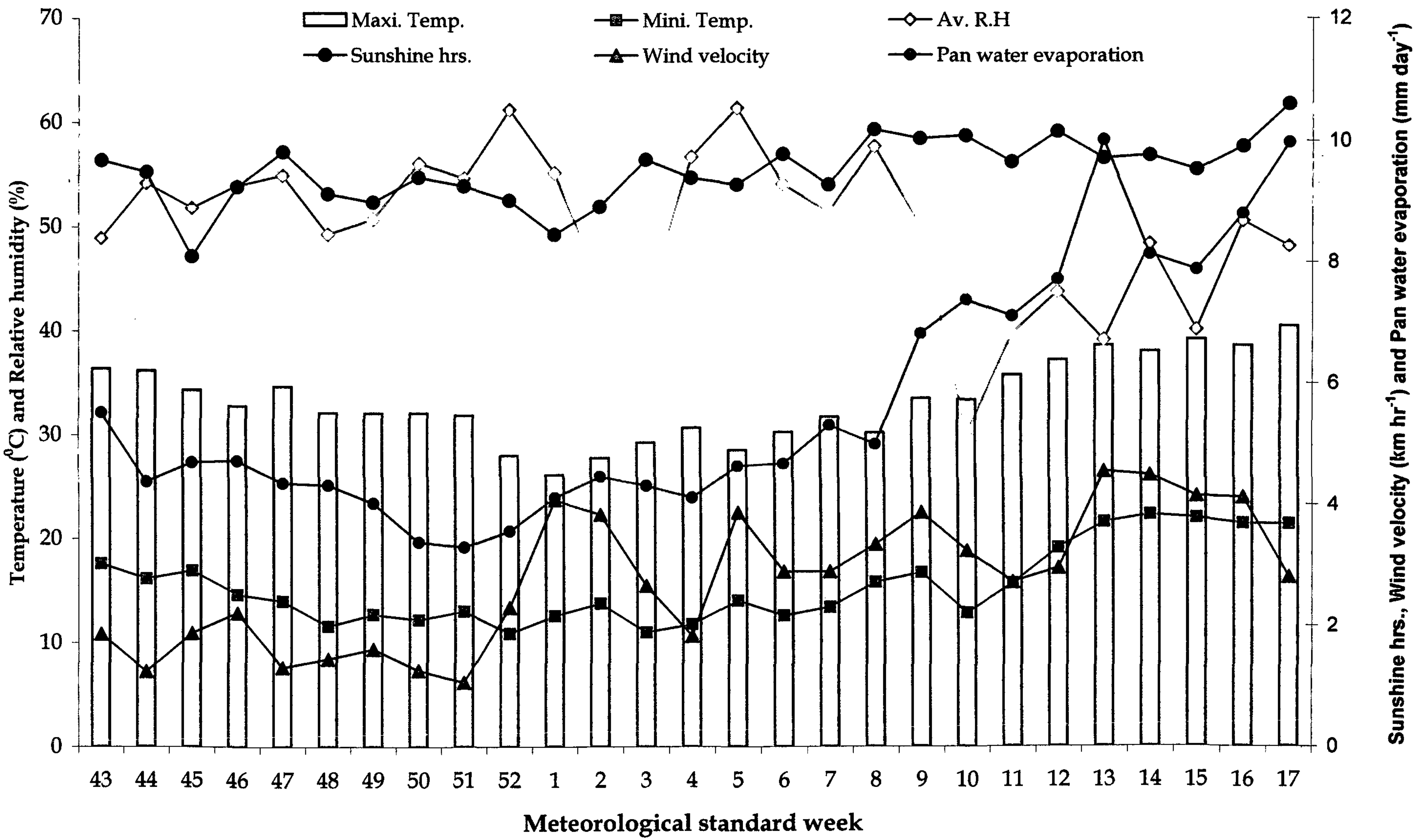



Fig. 3.1 : Mean weekly weather parameters recorded during the crop growth period of dill seed (2002-03)

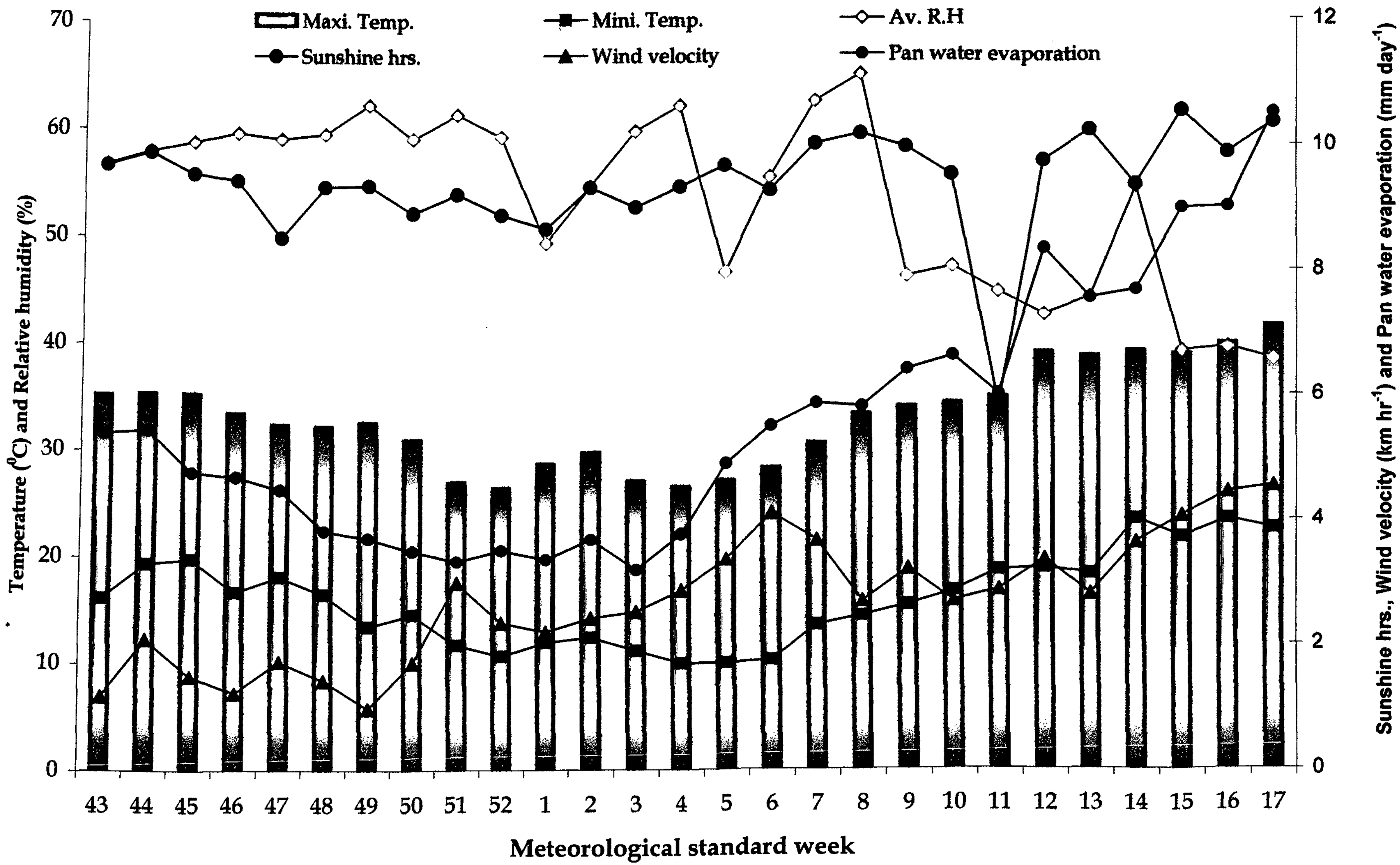



Fig. 3.2 : Mean weekly weather parameters recorded during the crop growth period of dill seed (2003-04)

This soil is suitable to variety of the crops of tropical and sub tropical regions. For determining the chemical properties of experimental site, soil samples were drawn randomly before conducting the experiment from different spots in the field at a depth of 0-15 cm and 15-30 cm and a composite sample was prepared and analysed for chemical properties of the soil. The values of soil analysis along with methods followed are furnished in Table 3.2.

**Table 3.2 : Physico - chemical properties of the experimental soil**

| Sr. No. | Soil Properties | Surface soil (0-7.5 cm) | | Method employed |
|---|---|---|---|---|
| | | 2002-03 | 2003-04 | |
| **A.** | **Mechanical composition** | | | |
| 1 | Coarse sand (%) | 0.50 | 0.50 | International pipette Method (Piper, 1980) |
| 2 | Fine sand (%) | 82.00 | 82.00 | |
| 3 | Silt (%) | 11.55 | 11.55 | |
| 4 | Clay (%) | 5.00 | 5.00 | |
| 5 | Textural Class | Loamy sand | | |
| **B.** | **Chemical Properties** | | | |
| 1 | Organic carbon (%) | 0.36 | 0.34 | Walkely and Black Method, Jackson (1973) |
| 2 | Total nitrogen (%) | 0.036 | 0.035 | Kjelhdahl Method Jackson (1973) |
| 3 | Available $P_2O_5$ (Kg $ha^{-1}$) | 53.00 | 54.50 | Olsen's Method (Chopra and Kanwar, 1976) |
| 4 | Available $K_2O$ (Kg $ha^{-1}$) | 359.85 | 355.75 | Flame photometric Method, Jackson (1973) |
| 5 | Soil pH (Soil:water, 1:2.5) | 7.50 | 7.80 | pH meter Jackson (1973) |
| 6 | Electrical Conductivity (dS $m^{-1}$) at $25^0C$ (Soil:water, 1:2.5) | 0.24 | 0.25 | Conductivity meter Jackson (1973) |

The physical constants of the experimental field for 0-15 and 15-30 cm depths of soil are given in Table 3.3.

**Table 3.3 : Physical constants of experimental field**

| Physical constants | Soil depth (cm) | | Method employed |
|---|---|---|---|
| | **0-15** | **15-30** | |
| Field capacity (%) | 17.5 | 17.0 | Actual Field Method (Dastane, 1972) |
| Permanent wilting point (%) | 5.10 | 4.80 | Sunflower Method (Dastane, 1972) |
| Bulk density (g $cc^{-1}$) | 1.45 | 1.54 | Core sampler Method (Dastane, 1972) |

It is evident from the data (Table 3.2) that the soil of the experimental field was loamy sand in texture, low in organic carbon and nitrogen, high in available phosphorous and high in potassium. The soil was free from any kind of salinity or sodicity hazards.

## 3.4 CROPPING HISTORY

Cropping history of the experimental field for the preceding two years is summarized in Table 3.4.

## 3.5 CROP AND VARIETY

The dill seed variety Gujarat Dill seed–1 is the latest variety developed through pedigree selection based on individual plant progeny performance from local germplasm collection at the Main Spices Research

Station, Gujarat Agricultural University, Jagudan. The details of the variety are presented in Table 3.5.

**Table 3.4 : Cropping history of the experimental field**

| Year | Season | Crop | Fertilizer (kg $ha^{-1}$) | | |
|---|---|---|---|---|---|
| | | | N | $P_2O_5$ | $K_2O$ |
| 2000-01 | *Kharif* | Sunhemp | - | - | - |
| | *Rabi* | Wheat | 120 | 60 | - |
| | Summer | Fallow | - | - | - |
| 2001-02 | *Kharif* | Sunhemp | - | | - |
| | *Rabi* | Wheat | 120 | 60 | - |
| | Summer | Fallow | - | - | - |
| 2002-03 | *Kharif* | Sunhemp | - | - | - |
| | *Rabi* | Dill seed | 40 | 20 | - |
| | Summer | Fallow | - | - | - |
| 2003-04 | *Kharif* | Sunhemp | - | - | - |
| | *Rabi* | Dill seed | 40 | 20 | - |
| | Summer | Fallow | - | - | - |

**Table 3.5 : Salient features of Gujarat Dill seed–1**

| Sr. No. | Name of characters | Description |
|---|---|---|
| 1 | Plant height (cm) | 148 |
| 2 | Days to 50% flowering | 86 |
| 3 | Days to maturity | 148 |
| 4 | No. of branches $plant^{-1}$ | 7.1 |
| 5 | No. of umbels $plant^{-1}$ | 25.9 |
| 6 | No. of umbellates $umbel^{-1}$ | 26.1 |
| 7 | No. of seeds $umbellate^{-1}$ | 90.3 |
| 8 | 1000 seed weight (g) | 4.2 |

## 3.6 EXPERIMENTAL DETAILS

In order to study the "Response of dill seed (*Anethum graveolens* L.) to irrigation and weed management practices under middle Gujarat Agro climatic condition" an experiment was conducted during *rabi* season of the year 2002-2003 and 2003-2004. The details of the experiment are given below.

### 3.6.1 Treatments

Twenty-eight treatment combinations involving four levels of irrigation and seven practices of weed management were embedded in this study.

**A. Main plot treatments**

**Irrigation Schedule (I) :**

$I_1$ : Irrigation at vegetative stage (40 DAS)
$I_2$ : Irrigation at vegetative stage (40 DAS) and at 50 % flowering (70 DAS)
$I_3$ : Irrigation at vegetative stage (40 DAS), at 50 % flowering stage (70 DAS) and at dough seed stage (100 DAS)
$I_4$ : Irrigation at 0.40 IW : CPE

Note : * One common irrigation for sowing was applied at a depth of 100 mm depth
* Depth of irrigation for treatment was 50 mm.

**B. Sub plot treatments**

**Weed management practices (W) :**

$W_1$ : Fluchloralin 1.0 kg $ha^{-1}$ (pre emergence)
$W_2$ : Pendimethalin 1.0 kg $ha^{-1}$ (pre emergence)
$W_3$ : Metolachlor 1.0 kg $ha^{-1}$ (pre emergence)
$W_4$ : Oxadiargyl 100 g $ha^{-1}$ (Pre emergence)

$W_5$ : One hand weeding at 3 WAS and earthing up at 6 WAS.
$W_6$ : Weed free (HW at 3 and 6 WAS)
$W_7$ : Weedy check

**Treatment combinations :**

There were twenty eight treatment combinations as given in Table 3.6.

**Table 3.6 Details of treatment combinations**

| Sr. No. | Treatment Combination | | Symbol |
|---|---|---|---|
| | Irrigation | Weed Management Practices | |
| 1 | $I_1$ | $W_1$ | $I_1W_1$ |
| 2 | $I_1$ | $W_2$ | $I_1W_2$ |
| 3 | $I_1$ | $W_3$ | $I_1W_3$ |
| 4 | $I_1$ | $W_4$ | $I_1W_4$ |
| 5 | $I_1$ | $W_5$ | $I_1W_5$ |
| 6 | $I_1$ | $W_6$ | $I_1W_6$ |
| 7 | $I_1$ | $W_7$ | $I_1W_7$ |
| 8 | $I_2$ | $W_1$ | $I_2W_1$ |
| 9 | $I_2$ | $W_2$ | $I_2W_2$ |
| 10 | $I_2$ | $W_3$ | $I_2W_3$ |
| 11 | $I_2$ | $W_4$ | $I_2W_4$ |
| 12 | $I_2$ | $W_5$ | $I_2W_5$ |
| 13 | $I_2$ | $W_6$ | $I_2W_6$ |
| 14 | $I_2$ | $W_7$ | $I_2W_7$ |
| 15 | $I_3$ | $W_1$ | $I_3W_1$ |
| 16 | $I_3$ | $W_2$ | $I_3W_2$ |
| 17 | $I_3$ | $W_3$ | $I_3W_3$ |
| 18 | $I_3$ | $W_4$ | $I_3W_4$ |
| 19 | $I_3$ | $W_5$ | $I_3W_5$ |
| 20 | $I_3$ | $W_6$ | $I_3W_6$ |
| 21 | $I_3$ | $W_7$ | $I_3W_7$ |
| 22 | $I_4$ | $W_1$ | $I_4W_1$ |
| 23 | $I_4$ | $W_2$ | $I_4W_2$ |
| 24 | $I_4$ | $W_3$ | $I_4W_3$ |
| 25 | $I_4$ | $W_4$ | $I_4W_4$ |
| 26 | $I_4$ | $W_5$ | $I_4W_5$ |
| 27 | $I_4$ | $W_6$ | $I_4W_6$ |
| 28 | $I_4$ | $W_7$ | $I_4W_7$ |

### 3.6.2 Details of layout

Layout plan with random allocation of treatments is depicted in Fig. 3.3.

The experimental details are as under.

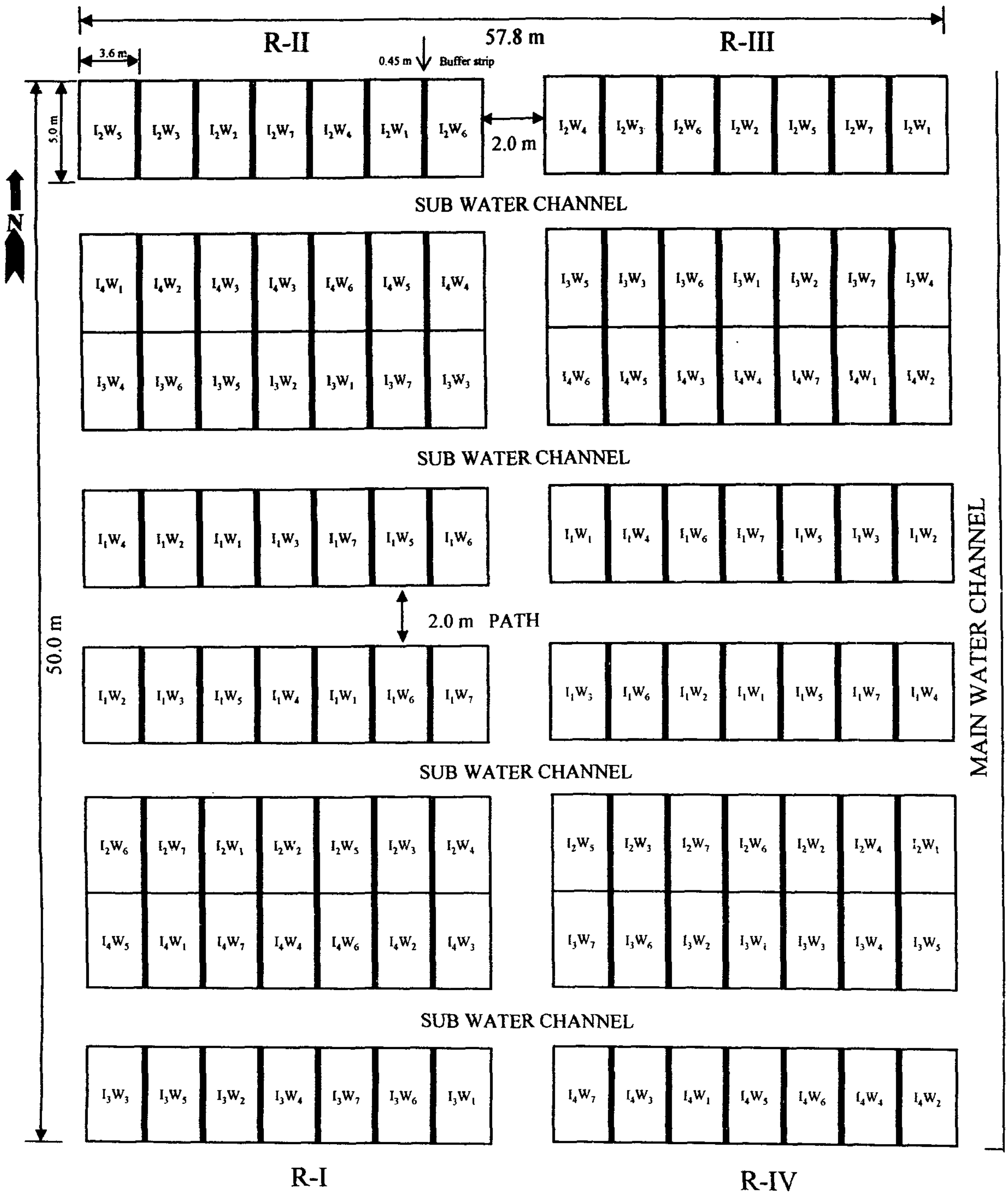
| | | |
|---|---|---|
| 1. | Design | : Split plot |
| 2. | Replications | : Four |
| 3. | Number of treatment combinations | : 28 |
| 4. | Number of plots / Replication | : 28 |
| 5. | Total number of plots | : 112 |
| 6. | Area of one replication | : 30 x 28 $m^2$ |
| 7. | Total area of whole experiments | : 57.8 x 50 $m^2$ |
| 8. | Plot size | : Gross: 5.0 m x 3.6 m<br>Net : 3.0 m x 1.8 m |
| 9. | Buffer strip | : Between replication : 2.0 m |
| 10. | Spacing | : 45 cm x 15 cm |
| 11. | Seed rate | : 6 kg $ha^{-1}$ |
| 12. | Crop and variety | : Gujarat Dill seed–1 |

## 3.7 CULTURAL OPERATIONS

After removal of residues of the previous crop along with the weeds, the experimental field was prepared for sowing with tractor cultivator followed by harrowing and planking. The sequences of operations carried out in the field during the crop season are given in Table 3.7.

*Plate 3.1* : A view of the experimental site

**Fig. 3.3 : Layout plan of experimental field**




Design : Split Plot Design

Plot size : Gross : 5 x 3.6 $m^2$ Net : 3 x 1.8 $m^2$

Replication: Four

**Table 3.7 : Calendar of operations carried out during experimental period**

| Sr. No. | Operations | Date | |
|---|---|---|---|
| | | 2002-03 | 2003-04 |
| 1 | Tractor cultivation (Cross-wise) | 14.10.02 | 17.10.03 |
| 2 | Harrowing and planking | 17.10.02 | 20.10.03 |
| 3 | Field layout | 19.10.02 | 22.10.03 |
| 4 | Preparation of beds and irrigation channels | 20.10.02 | 23.10.03 |
| 5 | Opening of furrows and fertilizer application | 21.10.02 | 24.10.03 |
| 6 | Sowing | 21.10.02 | 24.10.03 |
| 7 | Irrigation (common) | 21.10.02 | 24.10.03 |
| 8 | Application of herbicides | 22.10.02 | 25.10.03 |
| 9 | Thinning | 21.11.02 | 24.11.03 |
| 10 | Weeding | As per treatments | |
| 11 | Earthing up | 1.12.02 | 4.12.02 |
| 12 | Irrigation | As per treatments | |
| 13 | Fertilizer application | 1.12.02 | 4.12.03 |
| 14 | Wettable sulphur spraying (80 WP) | 4.1.03 | 9.1.04 |
| 15 | Harvesting | 27.3.03 | 29.3.04 |
| 16 | Threshing and winnowing | 31.3.03 | 2.4.04 |

## 3.8 FERTILIZER APPLICATION

The crop was uniformly fertilized at the rate of 40-20-0; N – $P_2O_5$ – $K_2O$ kg $ha^{-1}$ in the form of urea and DAP, respectively. At the time of sowing, half dose of nitrogen and full dose of phosphorus were thoroughly mixed and placed 5 cm deep from the seed lines and was covered with soil. Remaining half dose of nitrogen was applied as top dressing at 40 DAS.

## 3.9 SOWING

Dill seed variety Gujarat Dill Seed–1 was sown on 21st October in 2002-03 and 24th October in 2003-04. Seeds were sown at 3 to 4 cm depth keeping inter row spacing of 45 cm. A uniform seed rate of 6 kg $ha^{-1}$ was used.

## 3.10 THINNING

Thinning operation was made at 30 DAS keeping 15 cm distance between two plants to maintain equal plant population in all the plots.

## 3.11 IRRIGATION

One common irrigation was given to all the plots for getting uniform plant stand of the crop. Thereafter, irrigation was given according to treatment with fixed depth of 50 mm water at each irrigation.

Daily evaporation was recorded from US Class-A open pan evaporimeter installed in the agrometeorological observatory located near experimental plot. Cumulative pan evaporation (CPE) was calculated on daily basis when CPE Values reached at 125 mm for IW : CPE of 0.40.

The irrigation intervals and dates of irrigation for different treatments are given in Table 3.8.

**Table 3.8 : Dates and intervals of irrigation**

| Irrigation | $I_1$ | | $I_2$ | | $I_3$ | | $I_4$ | |
|---|---|---|---|---|---|---|---|---|
| | **2002-03** | **2003-04** | **2002-03** | **2003-04** | **2002-03** | **2003-04** | **2002-03** | **2003-04** |
| Common | 21.10.2002 | 24.10.2003 | 21.10.2002 | 24.10.2003 | 21.10.2002 | 24.10.2003 | 21.10.2002 | 24.10.2003 |
| $1^{st}$ | 29.11.2002 (40) | 3.12.2003 (40) | 29.11.2002 (40) | 3.12.2003 (40) | 29.11.2002 (40) | 3.12.2003 (40) | 27.11.2002 (38) | 5.11.2003 (33) |
| $2^{nd}$ | -- | -- | 29.12.2002 (30) | 3.1.2004 (30) | 29.12.2002 (30) | 3.1.2004 (30) | 1.1.2003 (35) | 30.12.2003 (35) |
| $3^{rd}$ | -- | -- | -- | -- | 28.1.2003 (30) | 2.2.2004 (29) | 31.1.2003 (30) | 2.2.2004 (34) |
| $4^{th}$ | -- | -- | -- | -- | -- | -- | 25.2.2003 (25) | 29.2.2004 (27) |

Figures in parentheses indicate the interval between successive irrigation.

### 3.11.1 Water use efficiency (kg ha$^{-1}$ mm$^{-1}$)

Water use efficiency was worked out by dividing the yield of dill seed (kg ha$^{-1}$) with the amount of water applied in mm ha$^{-1}$ and expressed in kg of grain produced ha$^{-1}$ mm of water applied which was worked out by the following formula.

$$WUE = \frac{Y}{CU}$$

Where,

WUE = Water use efficiency (kg ha$^{-1}$ mm$^{-1}$)
Y = Grain yield (kg ha$^{-1}$)
CU = Total consumptive use of water (mm)

## 3.12 INFORMATION OF HERBICIDES

Herbicides *viz.,* pendimethalin, fluchloralin, metolachlor and oxadiargyl were included in the study for weed management practices. The particulars and general properties of each herbicides are given in Table 3.9.

### 3.12.1 Preparation and application of herbicides

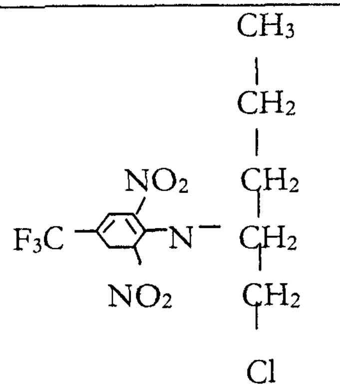
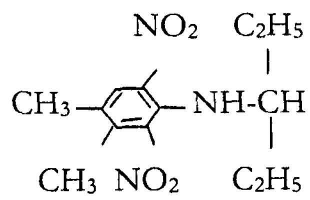
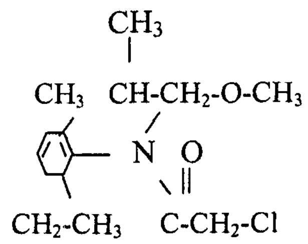
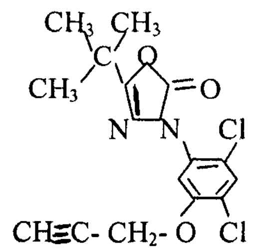
The required quantity of trade formulation of herbicides for each gross plot of 18.00 m$^2$ was calculated by using the following formula :

$$Rh = \frac{Ai \times At}{Ci} \times 100$$

Where,

Rh = Required quantity of trade formulation of herbicides (lit ha$^{-1}$)
Ai = Quantity of active ingredient to be applied (kg)
At = Area to be treated (ha)
Ci = Concentration of active ingredient in the trade formulation

**Table 3.9: The particulars of the herbicides used in the study**

| Sr. No. | Particulars | Fluchloralin | Pendimethalin | Metolachlor | Oxadiargyl |
|---|---|---|---|---|---|
| 1 | Manufacturer | BASF India Ltd., Mumbai. | Cynamid India Ltd.and Rallies India Ltd. | Hindustan Syngenta India Ltd. | Aventis Crop Science, Mumbai. |
| 2 | Chemical name | N(2-Chloroethyl)-2, 6 dinitro-N-Propyl-4 (trifluoromethyl) aniline | N-(1-ethyl propyl)-3, 4-dimethyl-2, 6 dinitrobenzeanine | 2–chloro–N–(2-ethyl-6-methylphenyl)–N–(2-Methoxy–1–methylethyl) acetamide | 3-(2,4-dichloro-5-(2-propynyloxy) phenyl)-5-(1,1-dimethylethyl)-1,3,4-oxadiazol-2(3H)-one |
| 3 | Trade name | Basalin 45 % EC | Stomp 30 % EC | Dual 50 % EC | Raft 6 % EC |
| 4 | Chemical structure |  |  |  |  |
| 5 | Group | Dinitroaniline | Dinitroaniline | Amide | Unclassified herbicide |

Accordingly, the required quantity of herbicide formulation was determined by the formula for different herbicidal treatments as given in Table 3.10.

**Table 3.10: Information on the applications of herbicides in field**

| Sr. No. | Technical name of herbicide | Trade name of herbicide | Application rate | | Quantity of herbicide required $plot^{-1}$ (ml) |
|---|---|---|---|---|---|
| | | | a. i. kg $ha^{-1}$ | Product $ha^{-1}$ | |
| 1 | Fluchloralin | Basalin 45% EC | 1.0 | 2.22 | 2.0 |
| 2 | Pendimethalin | Stomp 30 %EC | 1.0 | 3.33 | 6.0 |
| 3 | Metolachlor | Dual 50 %EC | 1.0 | 2.00 | 3.6 |
| 4 | Oxadiargyl | Raft 6 %EC | 0.1 | 1.66 | 3.0 |

## 3.13 CULTURAL WEED MANAGEMENT

Hand weeding was done with the help of weeding hook in $W_5$ treatment at 3 WAS and earthing up at 6 WAS, while in treatment $W_6$ hand weeding was done at 3 WAS and 6 WAS.

## 3.14 PLANT PROTECTION MEASURES

Dill seed crop was affected by powdery mildew. Adequate plant protection measures were taken. Wettable Sulphur (80 WP) was sprayed to check the damage during both the years.

## 3.15 HARVESTING AND THRESHING

Five randomly selected plants were harvested for recording necessary biometric (growth) observation and produce was added to respective net plot later on. The borderlines were harvested first and were removed from the experimental area. The crop from net plot area was harvested separately and left for sun drying in respective plots. After complete drying, the harvested produce was weighed just before threshing to record biological yield. Thereafter, threshing was done with the help of thresher. Seeds were winnowed, cleaned and weighed. The crop was harvested as and when matured.

## 3.16 WEED PARAMETERS

### 3.16.1 Density of weeds

Weed counts were taken at 21 and 42 DAS using quadrant 0.50 m x 0.50 m. The number of monocot, dicot and sedge weeds falling within the quadrate were counted separately and recorded.

### 3.16.2 Dry weight of weeds

The weed samples were collected at 21 and 42 DAS from 0.25 $m^2$ area and expressed as g $m^{-2}$ and at the time of harvest from entire net plot area of each plot and expressed as kg $ha^{-1}$. These samples were sun dried and then finally dried in the oven at $70^0$ C for 3 days. The dry weight of weed was recorded when weed samples were completely dried.

### 3.16.3 Weed Index (WI)

The yield reduction (%) owing to the presence of weeds was estimated by using the formula developed by Gill and Kumar (1969) and expressed as WI (%).

$$WI(\%) = \frac{x-y}{x} \times 100$$

Where,

WI = Weed index in percent
x = Yield of plot having minimum weeds
y = Yield of treated plot.

### 3.16.4 Weed Control Efficiency (WCE)

The weed control efficiency was calculated by using the following formula (Kondap and Upadhyay, 1985).

$$WCE(\%) = \frac{DWC - DWT}{DWC} \times 100$$

Where,

WCE = Weed control efficiency in percent
DWC = weed dry weight in control plot.
DWT = weed dry weight in treated plot.

## 3.17 BIOMETRIC OBSERVATIONS

### 3.17.1 Plant Population

Number of plants per meter row length recorded at harvest were counted at three spots selected randomly in each plot. The data were analysed statistically.

### 3.17.2 Days to 50% flowering

Number of days required for the crop to attain 50 percent flowering was recorded by randomly selecting five plants from each net plot. The mean value (in days) for each experimental plot was worked out and recorded.

### 3.17.3 Days to maturity

Number of days required by the crop to attain maturity was recorded for individual plot. The mean value (in days) was worked out and recorded.

### 3.17.4 Plant height

The plant height was measured at an interval of 6, 12 and 18 WAS and at harvest from the five randomly selected and tagged plants in each plot. The average figure of plant height was used for statistical analysis.

### 3.17.5 Number of branches plant$^{-1}$

Branches of the plant from previously tagged five plants were counted in each net plot at harvest. Data were averaged out to record the number of branches plant$^{-1}$.

### 3.17.6 Number of umbels plant$^{-1}$

The average number of umbel plant$^{-1}$ were recorded at harvest on the basis of five randomly selected plants from each net plot and mean value was worked out and recorded separately.

### 3.17.7 Number of umbellates umbel$^{-1}$

For counting the number of umbellates, five umbels were taken from previously selected plants from each plot and mean value was worked out and recorded separately.

### 3.17.8 Number of seeds umbellate$^{-1}$

For counting the number of seeds umbellate$^{-1}$, the umbel taken for counting the umbellate were used. The average number of seeds umbellate$^{-1}$ was worked out and recorded separately.

### 3.17.9 Test weight (g)

The composite samples of seeds drawn from the produce of each net plot, 1000 seeds were counted and the total weight was recorded for all the experimental plots.

## 3.18 YIELD

### 3.18.1 Seed yield (kg ha$^{-1}$)

The total biological mass of each net plot was collected separately in threshing yard and was allowed to dry under shed condition. After getting dryness, threshing was done and cleaned the seed manually. The seed yield of net plot was recorded and the seed yield obtained from each plot was converted into kg ha$^{-1}$.

### 3.18.2 Straw yield (kg ha$^{-1}$)

Straw yield was obtained by subtracting the seed yield of each net plot from their respective total dry matter (above ground) or biological yield and computed in terms of kg ha$^{-1}$.

### 3.18.3 Harvest Index (%)

Harvest index is the ratio of economic yield to the biological yield $plot^{-1}$. It was calculated by using following formula. (Donald and Hambling, 1976)

$$\text{Harvest Index (\%)} = \frac{\text{Economical yield (kg ha}^{-1}\text{)}}{\text{Biological yield (kg ha}^{-1}\text{)}} \times 100$$

## 3.19 CHEMICAL STUDIES

Chemical studies pertaining to nutrient content and uptake by grain and straw of dill seed as well as by weeds in dill seed crop and oil content of dill seed were determined for both the years of experimentation as described here after.

### 3.19.1 Uptake of nutrients

Representative samples of seed, straw and weeds were drawn from each treatment for chemical studies. They were oven dried at $70^0$ C for 24 hours and were powdered in a Willey mill. Prepared samples were analysed for nitrogen, phosphorus and potassium content. The nitrogen from seed and straw of dill seed and weeds were estimated by Kjeldahl's method (Jackson, 1973). The acid extract was prepared by digesting the material in diacid mixture. P content was determined by using Olsens method (Chopra and Kanwar, 1976) and K content was estimated by flame photometric method (Jackson, 1973).

Uptake values of nitrogen, phosphorus, and potassium by dill seed and straw and weeds for each plot were calculated by using the following formula.

$$\text{Nutrient uptake (kg ha}^{-1}) = \frac{\text{Percent nutrient content x yield of grain or straw or weeds (kg ha}^{-1})}{100}$$

**3.19.2 Oil content (%) in seed**

Oil content of dill seed was determined with the help of hydro distillation method as suggested by Ramachandraiah *et al.* (1988).

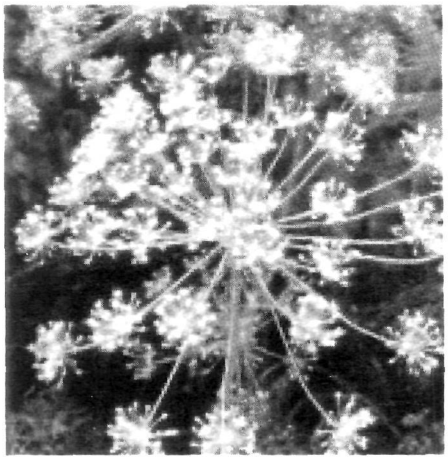
**3.20 STATISTICAL ANALYSIS**

Data on different aspect of dill seed crop were subjected to statistical analysis as per the procedure of Spilt Plot Design by computer system at the computer center, Department of Agricultural statistics, B. A. College of Agricultural, AAU, Anand. The value of 'F' was worked out and compared with the value of table 'F' at 5 percent level of significance. The value of standard error of mean (S. Em. $\pm$) and co-efficient of variation (C.V. %) were also calculated.

**3.21 ECONOMICS**

The gross realization in terms of rupees per hectare was estimated for each treatment on the basis of the dill seed yield and the prevailing market price during each year. The cost of cultivation of crop for each treatment was worked out taking into consideration the cost of all operation from land preparation to harvesting and the cost of inputs used such as seeds, fertilizer, irrigation, insecticides, fungicides, etc. The net realization was worked out by deducting the total cost of cultivation from the gross realization per hectare and recorded separately for each treatment. CBR (Cost Benefit Ratio) values were calculated on the basis of formula given below.

$$CBR = \frac{\text{Total realization } (Rs. ha^{-1})}{\text{Total expenditure } (Rs. ha^{-1})}$$



# Experimental Findings

# IV. EXPERIMENTAL FINDINGS

The results obtained from the present investigation on **"Response of dill seed (*Anethum graveolens* L.) to irrigation and weed management practices under middle Gujarat Agro climatic condition"** carried out during the *Rabi* season of the year 2002-03 and 2003-04 were reported in this chapter. Data obtained in the present investigation are reported alongwith statistical inferences. The results of various parameters are presented under the following heads.

4.1 Growth characters

4.2 Yield attribute characters and yield

4.3 Quality and nutrient content analysis in dill seed

4.4 Water use efficiency

4.5 Weed studies

4.6 Economics

## 4.1 GROWTH CHARACTERS

### 4.1.1 Plant population (No. $m^{-1}$ row length) of dill seed

Mean data presented in Table 4.1 indicated the plant population of dill seed recorded at 10 days after sowing (DAS) and at harvest as affected by different levels of irrigation and weed management practices during both the years of study and in pooled analysis.

#### 4.1.1.1 Effect of irrigation on plant population

Results reported in Table 4.1 showed the non-significant differences in plant population due to various irrigation schedules recorded at 10 DAS and at harvest.

#### 4.1.1.2 Effect of weed management practices on plant population

It is evident from the data furnished in Table 4.1 that there were significant influence on plant population due to different weed management practices.

At 10 DAS, the maximum plant population was observed under treatment $W_5$ (9.21) which remained at par with $W_3$ and $W_2$ during 2002-03, while $W_6$ (9.11) showed significantly higher plant population which was at par with $W_5$ and $W_2$ during 2003-04. In pooled analysis, $W_5$ (9.15) showed significantly higher plant population, which was at par with $W_3$, $W_2$ and $W_6$. At harvest, treatment $W_1$ (fluchloralin 1.0 kg $ha^{-1}$ as PE) recorded maximum plant population which was statistically not differ with rest of the treatments except $W_4$ (4.91) in pooled analysis.

Significantly the lowest plant population was noticed with treatment $W_4$ during both the years of study and in pooled analysis at harvest.

### 4.1.1.3 Interaction effect of I x W on plant population

The interaction of I x W for plant population was absent during both the years of study and in pooled analysis.

**Table 4.1 : Effect of irrigation and weed management practices on plant population at 10 DAS and at harvest**

| Treatments | Plant population (No. $m^{-1}$ row length) | | | | | |
|---|---|---|---|---|---|---|
| | 10 DAS | | | At harvest | | |
| | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled |
| **Irrigation (I)** | | | | | | |
| $I_1$ | 8.61 | 8.61 | 8.61 | 6.16 | 6.35 | 6.26 |
| $I_2$ | 8.66 | 8.57 | 8.62 | 6.30 | 6.25 | 6.28 |
| $I_3$ | 8.57 | 8.66 | 8.62 | 6.08 | 6.26 | 6.17 |
| $I_4$ | 8.58 | 8.59 | 8.58 | 6.21 | 6.19 | 6.20 |
| S. Em. ± | 0.09 | 0.83 | 0.46 | 0.06 | 0.09 | 0.06 |
| C. D. at 5 % | NS | NS | NS | NS | NS | NS |
| C. V. % | 5.36 | 5.10 | 5.23 | 4.82 | 7.96 | 6.60 |
| **Weed management (W)** | | | | | | |
| $W_1$ | 8.90 | 8.96 | 8.93 | 6.47 | 6.60 | 6.54 |
| $W_2$ | 8.98 | 9.01 | 9.00 | 6.37 | 6.62 | 6.49 |
| $W_3$ | 9.11 | 8.91 | 9.01 | 6.42 | 6.52 | 6.47 |
| $W_4$ | 6.23 | 6.20 | 6.22 | 4.94 | 4.87 | 4.91 |
| $W_5$ | 9.21 | 9.09 | 9.15 | 6.53 | 6.39 | 6.46 |
| $W_6$ | 8.88 | 9.11 | 9.00 | 6.33 | 6.36 | 6.34 |
| $W_7$ | 8.93 | 8.95 | 8.94 | 6.27 | 6.47 | 6.37 |
| S. Em. ± | 0.09 | 0.10 | 0.10 | 0.07 | 0.16 | 0.09 |
| C. D. at 5 % | 0.24 | 0.27 | 0.26 | 0.19 | 0.44 | 0.24 |
| C. V. % | 3.93 | 4.42 | 4.18 | 4.40 | 10.04 | 7.79 |
| **Interaction** | NS | NS | NS | NS | NS | NS |

### 4.1.2 Plant height

Mean data on periodical plant height recorded at 6, 12 and 18 WAS and at harvest of dill seed as affected by different levels of irrigation and weed management practices are presented in Table 4.2.

#### 4.1.2.1 Effect of irrigation on plant height

The differences in plant height due to various irrigation schedules were found to be significant at all the growth stages of crop except recorded at 6 WAS. Data further revealed that plant height recorded at various intervals were increased with increasing levels of irrigations. The treatment $I_4$ recorded significantly the highest plant height at all the intervals except at 6 WAS during both the years and in pooled analysis. Significantly the lowest value for plant height of dill seed was noticed with $I_1$ level in both the years as well as in pooled analysis at 12 and 18 WAS and at harvest.

#### 4.1.2.2 Effect of weed management practices on plant height

Data furnished in Table 4.2 revealed that the plant height of dill seed recorded at all the growth stages were significantly influenced due to different weed control methods during both the years and in pooled analysis.

Among the various weed management treatments, $W_6$ (HW at 3 and 6 WAS) recorded significantly the highest plant height than those recorded under rest of the treatments at various intervals and at harvest except at 18 WAS and at harvest during 2002-03. Significantly the lowest plant height was recorded with treatment $W_7$ during both the years and in pooled analysis at all the growth periods.

### 4.1.2.3 Interaction effect of I x W on plant height

The interaction effect of irrigation schedules and weed management practices on plant height was found significant in individual years as well as in pooled analysis at 18 WAS and at harvest.

**Interaction effect of I x W on plant height at 18 WAS**

Interaction effect of irrigation schedules and weed management practices was found to be significant on plant height (cm) recorded at 18 WAS during 2002-03, 2003-04 and in pooled analysis (Table 4.3).

The data indicated that the treatment combination $I_4W_6$ recorded significantly the highest plant height 180.00 cm during 2002-03, 181.50 cm during 2003-04 and 180.75 cm in pooled analysis. Significantly the lowest plant height was recorded in $I_1W_7$ combination during both the years as well as in pooled analysis.

**Table 4.2 : Effect of irrigation and weed management practices on plant height (cm) at 6, 12 and 18 WAS and at harvest**

| Treatments | Growth Intervals | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6 WAS | | | 12 WAS | | | 18 WAS | | | At harvest | | |
| | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled |
| **Irrigation (I)** | | | | | | | | | | | | |
| $I_1$ | 23.09 | 23.05 | 23.07 | 119.07 | 120.79 | 119.93 | 142.14 | 143.11 | 142.63 | 145.00 | 146.71 | 145.46 |
| $I_2$ | 22.92 | 22.91 | 22.92 | 122.86 | 124.54 | 123.69 | 148.00 | 149.32 | 148.66 | 151.21 | 152.89 | 152.05 |
| $I_3$ | 22.68 | 22.66 | 22.67 | 126.86 | 128.75 | 127.80 | 154.46 | 155.86 | 155.16 | 157.29 | 160.11 | 158.70 |
| $I_4$ | 22.67 | 22.86 | 22.8 | 131.21 | 133.21 | 132.21 | 157.61 | 159.07 | 158.34 | 160.68 | 163.10 | 161.89 |
| S. Em. ± | 0.13 | 0.13 | 0.09 | 0.34 | 0.30 | 0.22 | 0.62 | 0.50 | 0.40 | 0.67 | 0.53 | 0.43 |
| C. D. at 5 % | NS | NS | NS | 1.07 | 0.95 | 0.66 | 2.01 | 1.59 | 1.19 | 2.14 | 1.71 | 1.27 |
| C. V. % | 3.14 | 3.03 | 3.08 | 1.42 | 1.23 | 1.33 | 2.11 | 1.74 | 1.98 | 2.31 | 1.82 | 2.07 |
| **Weed management (W)** | | | | | | | | | | | | |
| $W_1$ | 22.08 | 23.03 | 23.05 | 142.00 | 143.81 | 142.81 | 167.31 | 168.63 | 167.97 | 170.12 | 171.50 | 170.81 |
| $W_2$ | 23.12 | 23.03 | 23.08 | 131.94 | 133.69 | 132.81 | 156.06 | 157.25 | 156.66 | 158.56 | 161.19 | 159.88 |
| $W_3$ | 22.16 | 22.21 | 22.18 | 125.00 | 126.75 | 125.88 | 150.63 | 151.75 | 151.19 | 153.62 | 155.56 | 154.59 |
| $W_4$ | 23.45 | 23.46 | 23.46 | 119.25 | 121.88 | 120.16 | 142.50 | 143.69 | 143.09 | 145.81 | 147.63 | 146.72 |
| $W_5$ | 23.81 | 23.80 | 23.81 | 134.88 | 136.88 | 135.88 | 163.00 | 164.19 | 163.59 | 166.13 | 168.38 | 167.25 |
| $W_6$ | 24.69 | 24.69 | 24.69 | 145.00 | 146.88 | 145.94 | 169.56 | 171.38 | 170.47 | 172.75 | 175.50 | 174.13 |
| $W_7$ | 19.89 | 19.89 | 19.89 | 76.94 | 78.69 | 77.81 | 104.81 | 106.00 | 105.41 | 107.81 | 110.19 | 109.00 |
| S. Em. ± | 0.15 | 0.15 | 0.11 | 0.81 | 0.81 | 0.57 | 0.91 | 0.83 | 0.62 | 0.93 | 0.86 | 0.63 |
| C. D. at 5 % | 0.44 | 0.44 | 0.31 | 2.28 | 2.29 | 1.60 | 2.58 | 2.35 | 1.42 | 2.64 | 2.42 | 1.77 |
| C. V. % | 2.73 | 2.74 | 2.73 | 2.58 | 2.56 | 2.57 | 2.43 | 2.19 | 2.31 | 2.43 | 2.20 | 2.32 |
| **Interaction** | NS | NS | NS | NS | NS | NS | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. |

**Table 4.3 : Interaction effect of irrigation (I) and weed management practices (W) on plant height (cm) at 18 WAS during 2002-03, 2003-04 and pooled analysis**

| Irrigation (I) | Weed management practices (W) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ | $W_6$ | $W_7$ |
| **2002-03** | | | | | | | |
| $I_1$ | 162.25 | 146.75 | 140.75 | 129.50 | 159.75 | 165.00 | 91.00 |
| $I_2$ | 164.50 | 154.50 | 147.25 | 138.75 | 160.25 | 161.75 | 109.00 |
| $I_3$ | 168.00 | 159.75 | 155.25 | 147.50 | 164.25 | 171.50 | 115.00 |
| $I_4$ | 174.50 | 163.25 | 159.25 | 154.25 | 167.75 | 180.00 | 104.25 |
| S. Em. ± | 1.82 | | | | | | |
| C. D. at 5 % | 5.15 | | | | | | |
| C. V. % | 2.43 | | | | | | |
| **2003-04** | | | | | | | |
| $I_1$ | 163.50 | 147.50 | 141.50 | 130.75 | 160.50 | 166.25 | 91.75 |
| $I_2$ | 165.50 | 155.75 | 148.25 | 139.50 | 161.25 | 165.00 | 110.00 |
| $I_3$ | 169.50 | 161.00 | 156.75 | 148.75 | 165.75 | 172.75 | 116.50 |
| $I_4$ | 176.00 | 164.75 | 160.50 | 155.75 | 169.25 | 181.50 | 105.75 |
| S. Em. ± | 1.66 | | | | | | |
| C. D. at 5 % | 4.69 | | | | | | |
| C. V. % | 2.19 | | | | | | |
| **Pooled** | | | | | | | |
| $I_1$ | 162.88 | 147.13 | 141.13 | 130.13 | 160.13 | 165.63 | 91.38 |
| $I_2$ | 165.00 | 155.13 | 147.75 | 139.13 | 160.75 | 163.38 | 109.50 |
| $I_3$ | 168.75 | 160.38 | 156.00 | 148.13 | 165.00 | 172.13 | 115.75 |
| $I_4$ | 175.25 | 164.00 | 159.88 | 155.00 | 168.50 | 180.75 | 105.00 |
| S. Em. ± | 1.24 | | | | | | |
| C. D. at 5 % | 3.45 | | | | | | |
| C. V. % | 2.31 | | | | | | |

**Table 4.4 : Interaction effect of irrigation (I) and weed management practices (W) on plant height (cm) at harvest during 2002-03,2003-04 and pooled analysis**

| Irrigation (I) | Weed management practices (W) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ | $W_6$ | $W_7$ |
| **2002-03** | | | | | | | |
| $I_1$ | 165.25 | 148.25 | 143.75 | 132.75 | 163.25 | 168.00 | 93.75 |
| $I_2$ | 167.50 | 157.00 | 151.00 | 142.50 | 163.00 | 165.50 | 112.00 |
| $I_3$ | 170.75 | 162.75 | 158.00 | 150.25 | 167.50 | 174.25 | 117.50 |
| $I_4$ | 177.00 | 166.25 | 161.75 | 157.75 | 170.75 | 183.25 | 108.00 |
| S. Em. ± | 1.86 | | | | | | |
| C. D. at 5 % | 5.27 | | | | | | |
| C. V. % | 2.43 | | | | | | |
| **2003-04** | | | | | | | |
| $I_1$ | 167.25 | 151.25 | 145.25 | 134.25 | 164.25 | 169.75 | 95.00 |
| $I_2$ | 165.00 | 159.50 | 152.25 | 143.50 | 165.75 | 169.50 | 114.75 |
| $I_3$ | 173.75 | 165.25 | 160.50 | 153.00 | 170.50 | 177.00 | 120.75 |
| $I_4$ | 180.00 | 168.75 | 164.25 | 159.75 | 173.00 | 185.50 | 110.19 |
| S. Em. ± | 1.72 | | | | | | |
| C. D. at 5 % | 4.84 | | | | | | |
| C. V. % | 2.20 | | | | | | |
| **Pooled** | | | | | | | |
| $I_1$ | 166.25 | 149.75 | 144.50 | 133.50 | 163.75 | 168.88 | 94.38 |
| $I_2$ | 166.25 | 158.25 | 151.63 | 143.00 | 164.38 | 167.50 | 113.38 |
| $I_3$ | 172.25 | 164.00 | 159.25 | 151.63 | 169.00 | 175.63 | 119.13 |
| $I_4$ | 178.50 | 167.50 | 163.00 | 158.75 | 171.88 | 184.50 | 109.12 |
| S. Em. ± | 1.27 | | | | | | |
| C. D. at 5 % | 3.54 | | | | | | |
| C. V. % | 2.32 | | | | | | |

**Interaction effect of I x W on plat height at harvest**

The data presented in Table 4.4 showed the significant differences due to interaction of I x W in plant height at harvest during both the years and in pooled analysis.

The data furnished in Table 4.4 revealed that significantly the tallest plant were notice with $I_4W_6$ treatment combination, while, lowest value with $I_1W_7$ during both the years and in pooled analysis.

## 4.2 YIELD ATTRIBUTE CHARACTERS AND YIELD

### 4.2.1 Number of branches plant$^{-1}$

Data cited in Table 4.5 showed the effect of irrigation and weed management practices on number of branches plant$^{-1}$ recorded at harvest during the year of 2002-03 and 2003-04 and in pooled analysis.

#### 4.2.1.1 Effect of irrigation on number of branches plant$^{-1}$

The result presented in Table 4.5 indicated that the effect of irrigation schedules on number of branches plant$^{-1}$ was significant at harvest during the year 2002-03 and 2003-04 as well as in pooled analysis.

Data showed that with the increase in irrigation levels, the number of branches plant$^{-1}$ were increased. Significantly the highest number of branches plant$^{-1}$ were observed under treatment $I_4$ while, $I_1$ noticed significantly the lowest number of branches per plant during both the years and in pooled analysis. Number of branches plant$^{-1}$ were significantly differ with each other irrigation schedules during both the years and in pooled analysis which indicated major role of irrigation frequencies at various growth stages in dill seed crop grown on sandy loam soil in Middle Gujarat condition.

**Table 4.5 : Effect of irrigation and weed management practices on number of branches plant$^{-1}$ at harvest**

| Treatments | Number of branches plant$^{-1}$ | | |
|---|---|---|---|
| | 2002-03 | 2003-04 | Pooled |
| **Irrigation (I)** | | | |
| $I_1$ | 10.69 | 11.15 | 10.92 |
| $I_2$ | 11.59 | 12.20 | 11.89 |
| $I_3$ | 12.42 | 13.08 | 12.75 |
| $I_4$ | 13.75 | 14.48 | 14.11 |
| S. Em. ± | 0.06 | 0.08 | 0.05 |
| C. D. at 5 % | 0.20 | 0.26 | 0.15 |
| C. V. % | 2.78 | 3.41 | 3.13 |
| **Weed management (W)** | | | |
| $W_1$ | 13.29 | 13.98 | 13.63 |
| $W_2$ | 12.72 | 13.31 | 13.01 |
| $W_3$ | 12.00 | 12.64 | 12.32 |
| $W_4$ | 11.24 | 11.86 | 11.55 |
| $W_5$ | 12.97 | 13.67 | 13.32 |
| $W_6$ | 13.96 | 14.86 | 14.31 |
| $W_7$ | 8.60 | 8.98 | 8.79 |
| S. Em. ± | 0.11 | 0.11 | 0.08 |
| C. D. at 5 % | 0.32 | 0.32 | 0.22 |
| C. V. % | 3.70 | 3.57 | 3.63 |
| **Interaction** | Sig. | Sig. | Sig. |

**Table 4.6 : Interaction effect of irrigation (I) and weed management practices (W) on number of branches plant$^{-1}$ at harvest during 2002-03, 2003-04 and pooled analysis**

| Irrigation (I) | Weed management practices (W) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ | $W_6$ | $W_7$ |
| **2002-03** | | | | | | | |
| $I_1$ | 11.63 | 11.33 | 10.50 | 10.03 | 11.30 | 12.73 | 7.33 |
| $I_2$ | 13.13 | 12.20 | 11.18 | 10.60 | 12.75 | 13.63 | 7.68 |
| $I_3$ | 13.53 | 13.13 | 12.75 | 11.65 | 13.20 | 14.25 | 8.43 |
| $I_4$ | 14.88 | 14.23 | 13.58 | 12.70 | 14.63 | 15.25 | 10.98 |
| S. Em. ± | 0.22 | | | | | | |
| C. D. at 5 % | 0.63 | | | | | | |
| C. V. % | 3.70 | | | | | | |
| **2003-04** | | | | | | | |
| $I_1$ | 12.15 | 11.60 | 11.03 | 10.55 | 11.90 | 13.25 | 7.60 |
| $I_2$ | 13.78 | 12.85 | 11.75 | 11.18 | 13.45 | 14.33 | 8.05 |
| $I_3$ | 14.28 | 13.80 | 13.43 | 12.30 | 13.93 | 15.00 | 8.83 |
| $I_4$ | 15.70 | 14.98 | 14.35 | 13.40 | 15.41 | 16.05 | 11.45 |
| S. Em. ± | 0.22 | | | | | | |
| C. D. at 5 % | 0.64 | | | | | | |
| C. V. % | 3.57 | | | | | | |
| **Pooled** | | | | | | | |
| $I_1$ | 11.89 | 11.46 | 10.46 | 10.29 | 11.60 | 12.99 | 7.46 |
| $I_2$ | 13.45 | 12.53 | 11.46 | 10.89 | 13.10 | 13.98 | 7.86 |
| $I_3$ | 13.90 | 13.46 | 13.09 | 11.98 | 13.56 | 14.63 | 8.63 |
| $I_4$ | 15.29 | 14.60 | 13.96 | 13.05 | 15.21 | 15.65 | 11.21 |
| S. Em. ± | 0.16 | | | | | | |
| C. D. at 5 % | 0.44 | | | | | | |
| C. V. % | 3.63 | | | | | | |

#### 4.2.1.2 Effect of weed management practices on number of branches plant$^{-1}$

Results (Table 4.5) indicated the significant differences in number of branches plant$^{-1}$ due to different weed management practices.

The treatment $W_6$ (HW at 3 and 6 WAS) recorded significantly the highest number of branches plant$^{-1}$ during individual years as well as in pooled analysis. Treatment $W_1$ showed significantly second higher number of branches plant$^{-1}$ which was statistically at par with treatment $W_5$ during 2002-03 and 2003-04, but not at par in pooled analysis. The lowest number of branches plant$^{-1}$ were recorded in treatment $W_7$ (weedy check) during both the year as well as in pooled analysis.

#### 4.2.1.3 Interaction effect on branches plant$^{-1}$

The number of branches plant$^{-1}$ were significantly influenced by interactive effect of irrigation schedules and weed management practices during the year 2002-03 and 2003-04 as well as in pooled analysis (Table 4.6).

The perusal of data indicated that the treatment combination $I_4W_6$ noticed significantly higher number of branches plant$^{-1}$, which was at par with $I_4W_1$ and $I_4W_5$ during both years and in pooled analysis. Significantly lower number of branches plant$^{-1}$was recorded with treatment combination $I_1W_7$ which showed statistically no differences with $I_2W_7$ during both the years and in pooled results.

### 4.2.2 Days to 50 % flowering

The results pertaining of days to 50 % flowering as affected by different irrigation schedules and weed management practices during the year 2002-03 and 2003-04 and in pooled analysis are presented in Table 4.7.

**Table 4.7: Effect of irrigation and weed management practices on days to 50 % flowering and days to maturity of dill seed crop**

| Treatments | Days to 50 % flowering | | | Days to maturity | | |
|---|---|---|---|---|---|---|
| | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled |
| **Irrigation (I)** | | | | | | |
| $I_1$ | 85.54 | 86.04 | 85.79 | 136.14 | 135.71 | 135.93 |
| $I_2$ | 85.79 | 85.64 | 85.71 | 142.50 | 142.64 | 142.57 |
| $I_3$ | 85.71 | 85.82 | 85.77 | 146.82 | 146.18 | 146.50 |
| $I_4$ | 86.04 | 85.96 | 86.00 | 153.96 | 154.11 | 154.04 |
| S. Em. ± | 0.17 | 0.20 | 0.13 | 0.20 | 0.22 | 0.15 |
| C. D. at 5 % | NS | NS | NS | 0.64 | 0.71 | 0.45 |
| C. V. % | 11.06 | 11.26 | 11.18 | 10.74 | 10.81 | 10.79 |
| **Weed management (W)** | | | | | | |
| $W_1$ | 85.38 | 85.56 | 85.47 | 144.38 | 144.06 | 144.22 |
| $W_2$ | 86.38 | 85.88 | 86.13 | 144.50 | 144.69 | 144.59 |
| $W_3$ | 86.13 | 85.81 | 85.97 | 145.38 | 144.19 | 144.78 |
| $W_4$ | 85.56 | 86.06 | 85.81 | 144.81 | 144.75 | 144.78 |
| $W_5$ | 85.75 | 86.00 | 85.88 | 145.31 | 144.81 | 145.06 |
| $W_6$ | 86.25 | 86.94 | 86.59 | 146.00 | 146.44 | 146.22 |
| $W_7$ | 84.94 | 84.81 | 84.88 | 143.63 | 143.69 | 143.66 |
| S. Em. ± | 0.29 | 0.26 | 0.19 | 0.27 | 0.27 | 0.19 |
| C. D. at 5 % | 0.83 | 0.74 | 0.55 | 0.77 | 0.77 | 0.53 |
| C. V. % | 11.37 | 11.23 | 11.30 | 10.75 | 10.76 | 10.75 |
| **Interaction** | NS | NS | NS | NS | NS | NS |

### 4.2.2.1 Effect of irrigation on days to 50 % flowering

The difference in days to 50 % flowering (Table 4.7) as influenced by various irrigation schedules was non-significant. Numerically the higher days to 50 % flowering was recorded with $I_4$ during the year 2002-03 and 2003-04 and in pooled results.

### 4.2.2.2 Effect of weed management practices on days to 50 % flowering

There was significant difference in days to 50 % flowering (Table 4.7) due to different weed management practices. Significantly higher days to 50 per cent flowering was recorded in treatment $W_2$ (86.38 days) which was at par with all the treatments except $W_7$ and $W_1$ during 2002-03, while $W_6$ showed significantly the highest days to 50 per cent flowering (86.94 days) during 2003-04. In pooled analysis, treatment $W_6$ (86.59 days) showed significantly higher days to 50 per cent flowering, which was at par with treatment $W_2$. Treatment $W_2$was significantly at par in days to 50 per cent flowering of dill seed with treatment of $W_3$, $W_5$ and $W_4$ in pooled analysis

Significantly the lowest value for 50 per cent flowering was recorded with treatment $W_7$ during the year 2002-03 and 2003-04 and in pooled analysis.

### 4.2.2.3 Interaction effect of I x W on days to 50 % flowering

The non-significant differences in days to 50 per cent flowering was observed in interaction of irrigation and weed management practices during both the years and in pooled analysis.

### 4.2.3 Days to maturity

Data on days to maturity of dill seed crop as influenced by various irrigation schedules and weed management practices are furnished in Table 4.7 during both the years and in pooled results.

#### 4.2.3.1 Effect of irrigation on days to maturity

The critical examination of data (Table 4.7) showed that with increasing in the irrigation levels, the days to maturity of plant were increased. Treatment $I_4$ recorded significantly the highest days to maturity as compared to rest of the treatments while, the lowest days to maturity were recorded with $I_1$ during both the years and in pooled analysis.

#### 4.2.3.2 Effect of weed management practices on days to maturity

The data (Table 4.7) showed that the days to maturity were found to be significant due to different weed management practices.

Significantly the higher days to maturity was recorded with treatment $W_6$ (146.0 days) during 2002-03, which was statistically at par with $W_3$ and $W_5$. During 2003-04 and in pooled analysis, treatment $W_6$ showed significantly the highest days to maturity. The treatment $W_7$ showed significantly lower days to maturity during both the years and in pooled results but it was at par with $W_1$ during 2002-03 and 2003-04 and in pooled analysis.

#### 4.2.3.3 Interaction effect of I x W on days to maturity

Interaction effect of irrigation schedules and weed management practices was not observed on days to maturity during both the years and in pooled analysis.

### 4.2.4 Number of umbels plant$^{-1}$

The observation on number of umbels plant$^{-1}$ recorded at the time of harvest as affected by different irrigation levels and weed management practices is presented in Table 4.8 during both the years and in pooled analysis.

**Table 4.8 : Effect of irrigation and weed management practices on number of umbels $plant^{-1}$, umbellates $umbel^{-1}$ and seeds $umbellate^{-1}$ at harvest**

| Treatment | No. of umbellates $plant^{-1}$ | | | No. of umbellates $umbel^{-1}$ | | | No. of seeds $umbellate^{-1}$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled |
| **Irrigation (I)** | | | | | | | | | |
| $I_1$ | 13.98 | 13.83 | 13.90 | 17.78 | 17.53 | 17.65 | 20.28 | 20.19 | 20.23 |
| $I_2$ | 16.28 | 16.08 | 16.18 | 19.24 | 19.01 | 19.13 | 20.56 | 20.47 | 20.52 |
| $I_3$ | 18.32 | 18.15 | 18.24 | 20.75 | 20.52 | 20.64 | 20.91 | 20.76 | 20.84 |
| $I_4$ | 20.83 | 20.74 | 20.78 | 22.30 | 22.03 | 22.17 | 21.36 | 21.15 | 21.26 |
| S. Em. ± | 0.12 | 0.16 | 0.10 | 0.11 | 0.10 | 0.07 | 0.05 | 0.03 | 0.02 |
| C. D. at 5 % | 0.38 | 0.50 | 0.29 | 0.36 | 0.34 | 0.23 | 0.14 | 0.08 | 0.08 |
| C. V. % | 3.67 | 4.88 | 4.30 | 2.98 | 2.90 | 2.95 | 4.16 | 4.67 | 4.96 |
| **Weed management (W)** | | | | | | | | | |
| $W_1$ | 23.83 | 23.81 | 23.82 | 22.39 | 22.22 | 22.30 | 23.81 | 23.68 | 23.75 |
| $W_2$ | 17.51 | 17.38 | 17.44 | 20.81 | 20.56 | 20.68 | 21.29 | 21.15 | 21.22 |
| $W_3$ | 11.81 | 11.59 | 11.70 | 19.01 | 18.73 | 18.87 | 20.30 | 20.15 | 20.23 |
| $W_4$ | 10.07 | 9.79 | 9.93 | 17.88 | 17.59 | 17.73 | 18.35 | 18.19 | 18.27 |
| $W_5$ | 21.27 | 21.04 | 21.15 | 22.01 | 21.81 | 21.91 | 23.74 | 22.65 | 22.69 |
| $W_6$ | 28.46 | 28.51 | 28.48 | 25.59 | 25.44 | 25.51 | 25.27 | 25.15 | 25.21 |
| $W_7$ | 8.53 | 8.28 | 8.40 | 12.43 | 12.09 | 12.26 | 13.68 | 13.52 | 13.60 |
| S. Em. ± | 0.14 | 0.12 | 0.09 | 0.18 | 0.17 | 0.12 | 0.17 | 0.17 | 0.12 |
| C. D. at 5 % | 0.41 | 0.34 | 0.26 | 0.50 | 0.48 | 0.36 | 0.48 | 0.49 | 0.34 |
| C. V. % | 3.35 | 2.84 | 3.11 | 3.54 | 3.49 | 3.51 | 3.30 | 3.35 | 3.33 |
| **Interaction** | Sig. | Sig. | Sig. | NS | Sig. | Sig. | NS | NS | NS |

**Table 4.9 : Interaction effect of irrigation (I) and weed management practices (W) on number of umbels plant$^{-1}$ at harvest during 2002-03, 2003-04 and pooled analysis**

| Irrigation (I) | Weed management practices (W) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ | $W_6$ | $W_7$ |
| **2002-03** | | | | | | | |
| $I_1$ | 21.23 | 14.15 | 8.63 | 6.35 | 17.78 | 24.95 | 4.78 |
| $I_2$ | 21.78 | 16.93 | 10.85 | 9.40 | 20.18 | 26.95 | 7.90 |
| $I_3$ | 24.93 | 18.50 | 12.75 | 10.83 | 22.38 | 29.10 | 9.78 |
| $I_4$ | 27.40 | 20.45 | 15.03 | 13.70 | 24.75 | 32.85 | 11.65 |
| S. Em. ± | 0.29 | | | | | | |
| C. D. at 5 % | 0.82 | | | | | | |
| C. V. % | 3.35 | | | | | | |
| **2003-04** | | | | | | | |
| $I_1$ | 21.10 | 14.05 | 8.55 | 6.05 | 17.55 | 24.90 | 4.60 |
| $I_2$ | 21.65 | 16.78 | 10.48 | 9.18 | 20.03 | 26.78 | 7.70 |
| $I_3$ | 25.13 | 18.40 | 12.48 | 10.50 | 22.03 | 29.18 | 9.38 |
| $I_4$ | 27.38 | 20.28 | 14.88 | 13.45 | 24.55 | 33.18 | 11:45 |
| S. Em. ± | 0.24 | | | | | | |
| C. D. at 5 % | 0.69 | | | | | | |
| C. V. % | 2.84 | | | | | | |
| **Pooled** | | | | | | | |
| $I_1$ | 21.16 | 14.10 | 8.59 | 6.20 | 17.66 | 24.93 | 4.69 |
| $I_2$ | 21.71 | 16.85 | 10.66 | 9.29 | 20.10 | 26.86 | 7.80 |
| $I_3$ | 25.03 | 18.45 | 12.61 | 10.66 | 22.20 | 29.14 | 9.58 |
| $I_4$ | 27.39 | 20.36 | 14.95 | 13.58 | 24.65 | 33.01 | 11.50 |
| S. Em. ± | 0.19 | | | | | | |
| C. D. at 5 % | 0.53 | | | | | | |
| C. V. % | 3.11 | | | | | | |

#### 4.2.4.1 Effect of irrigation on number of umbels plant$^{-1}$

Number of umbels plant$^{-1}$ of dill seed recorded at harvest were significantly influenced by different levels of irrigation. It is further revealed that with increasing in irrigation levels, the umbels plant$^{-1}$ were also increased. The highest number of umbels plant$^{-1}$ were recorded under the treatment of $I_4$ during both the years and in pooled result, while the lowest number of umbels plant$^{-1}$ were recorded under treatment $I_1$ during individual years and in pooled analysis. Number of umbels plant$^{-1}$ were significantly differ with each other irrigation schedules treatments during individual years and also in pooled analysis.

#### 4.2.4.2 Effect of weed management practices on number of umbels plant$^{-1}$

It was observed from the data given in Table 4.8 that the differences due to different weed management practices were significant with respect to number of umbels plant$^{-1}$ recorded at harvest.

Significantly, the highest number of umbels plant$^{-1}$ were recorded under weed free treatment ($W_6$), while the lowest number of umbels plant$^{-1}$ were observed under treatment $W_7$ during both the years and in pooled analysis.

#### 4.2.4.3 Interaction effect of I x W on number of umbels plant$^{-1}$

Interaction effect of irrigation schedules and weed management practices on number of umbels plant$^{-1}$ were present in Table 4.9 for the years 2002-03 and 2003-04 and pooled analysis.

The interaction effect of irrigation schedules and weed management practices on number of umbels plant$^{-1}$ were significant during both the years and in pooled analysis. The treatment combination $I_4W_6$ recorded significantly the highest number of umbels plant$^{-1}$ during 2002-03, 2003-04 and in pooled analysis. Significantly the lowest number of umbels plant$^{-1}$ were noticed under treatment combination of $I_1W_7$ during both the years and in pooled analysis.

### 4.2.5 Number of umbellates umbel$^{-1}$

The mean data on number of umbellates umbel$^{-1}$ of dill seed recorded at harvest as affected by different irrigation schedules and weed management practices are presented in Table 4.8.

#### 4.2.5.1 Effect of irrigation on number of umbellates umbel$^{-1}$

The results presented in Table 4.8 revealed that the number of umbellates umbel$^{-1}$ of dill seed was significantly affected due to irrigation schedules during both the years and in pooled results.

It was further revealed that with increasing in irrigation levels, the number of umbellates umbel$^{-1}$ were increased. Significantly the highest number of umbellates umbel$^{-1}$ was recorded with treatment $I_4$ and the lowest number of umbellates umbel$^{-1}$ recorded under treatment $I_1$ during the year 2002-03 and 2003-04 and in pooled analysis.

#### 4.2.5.2 Effect of weed management practices on umbellates umbel$^{-1}$

The data pertaining to number of umbellates umbel$^{-1}$ as affected by various weed management practices were found to be significant during both the years and in pooled results. The highest number of umbellate umbel$^{-1}$ were noticed in treatment $W_6$, while, the lowest number of umbellates umbel$^{-1}$ were recorded in treatment $W_7$ of individual years and in pooled results. Significantly second higher number of umbellates umbel$^{-1}$ was recorded in $W_1$ (fluchloralin 1.0 kg ha$^{-1}$ as PE) which was at par with treatment $W_5$ (HW at 3 WAS and earthing up at 6 WAS) during individual years.

### 4.2.5.3 Interaction effect of I x W on umbellates $umbel^{-1}$

Interaction effect of irrigation and weed management practices on umbellates $umbel^{-1}$ was found significant during 2003-04 and in pooled analysis (Table 4.10).

It is apparent from the data presented in Table 4.10 that the treatment combination $I_4W_6$ recorded significantly the highest number of umbellate $umbel^{-1}$ during 2003-04 (28.53) and pooled analysis (28.56). The significantly lower number of umbellate $umbel^{-1}$ (9.83) noticed under $I_1W_7$ treatment combination during 2003-04. Same trend was noticed in the case of pooled analysis.

**Table 4.10 : Interaction effect of irrigation (I) and weed management practices (W) on number of umbellates $umbel^{-1}$ at harvest during 2003-04 and pooled analysis**

| Irrigation (I) | Weed management practices (W) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ | $W_6$ | $W_7$ |
| **2003-04** | | | | | | | |
| $I_1$ | 20.60 | 18.35 | 16.15 | 15.03 | 19.98 | 22.80 | 9.83 |
| $I_2$ | 21.28 | 20.30 | 17.95 | 17.03 | 21.40 | 24.05 | 11.08 |
| $I_3$ | 22.98 | 21.20 | 19.55 | 17.88 | 22.33 | 26.38 | 13.33 |
| $I_4$ | 24.03 | 22.38 | 21.25 | 20.43 | 23.55 | 28.53 | 14.13 |
| S. Em. $\pm$ | 0.34 | | | | | | |
| C. D. at 5 % | 0.97 | | | | | | |
| C. V. % | 3.49 | | | | | | |
| **Pooled** | | | | | | | |
| $I_1$ | 20.64 | 18.49 | 16.33 | 15.14 | 20.09 | 22.93 | 9.98 |
| $I_2$ | 21.38 | 20.40 | 18.10 | 17.20 | 21.48 | 24.09 | 11.25 |
| $I_3$ | 23.06 | 21.33 | 19.66 | 18.04 | 22.39 | 26.48 | 13.50 |
| $I_4$ | 24.14 | 22.53 | 21.39 | 20.56 | 23.70 | 28.56 | 14.31 |
| S. Em. $\pm$ | 0.28 | | | | | | |
| C. D. at 5 % | 0.69 | | | | | | |
| C. V. % | 3.52 | | | | | | |

### 4.2.6 Number of seeds umbellate$^{-1}$

The mean data on number of seeds umbellate$^{-1}$ recorded at harvest as influenced by various irrigation schedules and weed management practices were presented in Table 4.8 during both the years and in pooled results.

#### 4.2.6.1 Effect of irrigation on number of seeds umbellates$^{-1}$

It is seen from the data presented in Table 4.8 indicated that significant influences on number of seeds umbellate$^{-1}$ by various irrigation schedules. With increasing in irrigation levels, the seeds umbellate$^{-1}$ were increased. Significantly the maximum number of seeds in umbellates were recorded with $I_4$, while the minimum number of seeds in umbellates were recorded in treatment $I_1$ during both the years and in pooled results.

#### 4.2.6.2 Effect of weed management practices on number of seeds umbellate$^{-1}$

The data presented in Table 4.8 showed that the number of seeds per umbellate were significantly affected by different weed management practices during both the years and in pooled analysis. The treatment $W_6$ recorded significantly the highest number of seeds umbellate$^{-1}$, while lowest with treatment $W_7$ in the year 2002-03 and 2003-04 and in pooled analysis. The number of seeds umbellate$^{-1}$ was significantly differ by each other weed management practices during individual years and also in pooled analysis.

### 4.2.6.3 Interaction effect of I x W on number of seeds umbellate$^{-1}$

None of the interaction was found significant for number of seeds umbellate$^{-1}$ in individual years as well as in pooled analysis.

### 4.2.7 Seed yield

The mean data presented in Table 4.11 indicated the seed yield (kg ha$^{-1}$) of dill as affected by various irrigation schedules and weed management practices during the years of 2002-03 and 2003-04 and pooled results.

### 4.2.7.1 Effect of irrigation on seed yield

Data pertaining to seed yield (kg ha$^{-1}$) presented in Table 4.11 showed that seed yield of dill seed was significantly affected by various irrigation schedules.

A keen observation of data furnished in Table 4.11 indicated that with increasing irrigation levels, seed yield was also increased. Significantly the highest seed yield of 1508 kg ha$^{-1}$, 1410 kg ha$^{-1}$ and 1459 kg ha$^{-1}$ during 2002-03, 2003-04 and in pooled analysis, respectively, recorded in $I_4$ treatment.

Significantly lower seed yield of dill seed was recorded in $I_1$ treatment which was at par with treatment $I_2$ during 2002-03 (1040 kg ha$^{-1}$) and 2003-04 (1123 kg ha$^{-1}$). While in pooled analysis, $I_1$ treatment showed significantly the lowest seed yield of dill seed (1004 kg ha$^{-1}$).

**Table 4.11: Effect of irrigation and weed management practices on seed and straw yield of dill seed and harvest index at harvest**

| Treatment | Seed yield (kg $ha^{-1}$) | | | Straw yield (kg $ha^{-1}$) | | | Harvest index (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled |
| **Irrigation (I)** | | | | | | | | | |
| $I_1$ | 1040 | 968 | 1004 | 11679 | 10928 | 11334 | 7.59 | 7.30 | 7.45 |
| $I_2$ | 1123 | 1033 | 1078 | 12228 | 11712 | 11970 | 7.99 | 7.57 | 7.78 |
| $I_3$ | 1326 | 1226 | 1276 | 13730 | 12414 | 12698 | 8.78 | 8.35 | 8.56 |
| $I_4$ | 1508 | 1410 | 1459 | 12982 | 13115 | 13422 | 9.18 | 8.87 | 9.03 |
| S. Em. ± | 30 | 21 | 18 | 132 | 201 | 110 | 0.30 | 0.29 | 0.21 |
| C. D. at 5 % | 96 | 69 | 55 | 424 | 645 | 358 | 0.96 | 0.95 | 0.62 |
| C. V. % | 12.77 | 9.86 | 11.52 | 5.55 | 8.86 | 7.31 | 18.89 | 19.60 | 19.24 |
| **Weed management (W)** | | | | | | | | | |
| $W_1$ | 1781 | 1639 | 1710 | 16018 | 15393 | 15706 | 10.20 | 9.75 | 9.98 |
| $W_2$ | 1618 | 1497 | 1577 | 14791 | 14062 | 14427 | 10.01 | 9.51 | 9.76 |
| $W_3$ | 885 | 820 | 853 | 13680 | 12928 | 13304 | 6.34 | 6.06 | 6.20 |
| $W_4$ | 466 | 426 | 446 | 9594 | 9056 | 9325 | 4.63 | 4.40 | 4.51 |
| $W_5$ | 1738 | 1606 | 1672 | 14803 | 14120 | 14461 | 10.78 | 10.26 | 10.52 |
| $W_6$ | 2129 | 2017 | 2073 | 17523 | 16747 | 17135 | 11.02 | 10.77 | 10.90 |
| $W_7$ | 126 | 109 | 118 | 2175 | 2094 | 2135 | 5.72 | 5.47 | 5.57 |
| S. Em. ± | 42 | 31 | 26 | 450 | 327 | 278 | 0.43 | 0.41 | 0.30 |
| C. D. at 5 % | 120 | 90 | 74 | 1270 | 923 | 776 | 1.21 | 1.17 | 0.83 |
| C. V. % | 13.65 | 11.02 | 12.51 | 14.23 | 10.85 | 12.74 | 20.47 | 20.68 | 20.58 |
| **Interaction** | Sig. | Sig. | Sig. | NS | NS | NS | NS | NS | NS |

**Table 4.12 : Interaction effect of irrigation (I) and weed management practices (W) on seed yield (kg $ha^{-1}$) during 2002-03, 2003-04 and pooled analysis**

| Irrigation (I) | Weed management practices (W) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ | $W_6$ | $W_7$ |
| **2002-03** | | | | | | | |
| $I_1$ | 1599 | 949 | 708 | 247 | 1476 | 2215 | 83 |
| $I_2$ | 1747 | 1657 | 687 | 324 | 1763 | 1553 | 129 |
| $I_3$ | 1766 | 1594 | 1120 | 611 | 1719 | 2333 | 138 |
| $I_4$ | 2013 | 2270 | 1027 | 682 | 1993 | 2416 | 155 |
| S. Em. ± | 85 | | | | | | |
| C. D. at 5 % | 240 | | | | | | |
| C. V. % | 13.65 | | | | | | |
| **2003-04** | | | | | | | |
| $I_1$ | 1474 | 863 | 652 | 229 | 1358 | 2129 | 74 |
| $I_2$ | 1597 | 1530 | 638 | 296 | 1618 | 1442 | 111 |
| $I_3$ | 1634 | 1479 | 1050 | 555 | 1585 | 2164 | 115 |
| $I_4$ | 1851 | 2115 | 939 | 625 | 1863 | 2335 | 138 |
| S. Em. ± | 63 | | | | | | |
| C. D. at 5 % | 180 | | | | | | |
| C. V. % | 11.02 | | | | | | |
| **Pooled** | | | | | | | |
| $I_1$ | 1537 | 906 | 680 | 238 | 1417 | 2172 | 78 |
| $I_2$ | 1672 | 1593 | 663 | 310 | 1690 | 1497 | 120 |
| $I_3$ | 1700 | 1537 | 1085 | 583 | 1652 | 2248 | 127 |
| $I_4$ | 1932 | 2193 | 983 | 653 | 1928 | 2376 | 146 |
| S. Em. ± | 53 | | | | | | |
| C. D. at 5 % | 148 | | | | | | |
| C. V. % | 12.51 | | | | | | |

### 4.2.7.2 Effect of weed management practices on seed yield

Results reported in Table 4.11 indicated the significant effect of weed management practices on seed yield. Significantly the highest seed yield was recorded with treatment $W_6$ during individual year and in pooled analysis.

Treatment $W_1$ (fluchloralin 1.0 kg $ha^{-1}$ as PE)stood second and significantly higher in respect to seed yield of dill seed which was at par with treatment $W_5$ during the year 2002-03 and 2003-04 as well as in pooled analysis. The lowest seed yield was recorded under treatment $W_7$ during both the years and in pooled analysis.

#### 4.2.7.3 Interaction effect of I x W on seed yield

Interaction effect of I x W on seed yield was presented in Table 4.12. It was revealed that significantly higher seed yield (2416 kg $ha^{-1}$) was recorded with treatment combination of $I_4W_6$, which was statistically at par with $I_3W_6$ (2333 kg $ha^{-1}$), $I_4W_2$ (2270 kg $ha^{-1}$) and $I_1W_6$ (2215 kg $ha^{-1}$) during 2002-03. During 2003-04 and in pooled analysis, treatment combination $I_4W_6$ showed significantly higher seed yield (2335 kg $ha^{-1}$) during 2003-04 and in pooled analysis (2376 kg $ha^{-1}$), which was at par with only combination of $I_3W_6$.

Significantly the lower seed yield was recorded under treatment combination of $I_1W_7$ which was at par with $I_2W_7$, $I_3W_7$, $I_4W_7$, $I_1W_4$ and $I_2W_4$ during 2002-03. During 2003-04 and in pooled analysis, $I_1W_7$ showed significantly lower seed yield which was at par with treatment combinations of $I_2W_7$, $I_3W_7$, $I_4W_7$ and $I_1W_4$.

### 4.2.8 Straw yield

Data pertaining to straw yield (kg $ha^{-1}$) recorded at harvest as affected by irrigation schedules and weed management practices are presented in Table 4.11 during both the years and in pooled analysis.

#### 4.2.8.1 Effect of irrigation on straw yield

A perusal of data presented in Table 4.11 indicated the significant influencing due to irrigation schedules on straw yield. It is further revealed that with increasing in irrigation levels, straw yield was increased. Significantly the highest straw yield was produced under treatment $I_4$ while, significantly the lowest straw yield was recorded under $I_1$ during both the years and in pooled analysis.

#### 4.2.8.2 Effect of weed management practices on straw yield

It is evident from the data presented in Table 4.11 that the treatment $W_6$ recorded significantly the highest straw yield, while, the lowest straw yield was produced in treatment $W_7$ during both the years and in pooled analysis.

#### 4.2.8.3 Interaction effect of I x W on straw yield

Interaction effect of I x W was absent during both the years and in pooled analysis in the case of straw yield.

### 4.2.9 Harvest Index (%)

Data pertaining to the effect of irrigation and weed management practices on harvest index are presented in Table 4.11 for the year 2002-03 and 2003-04 and pooled analysis.

#### 4.2.9.1 Effect of irrigation on harvest index

Calculated harvest index presented in Table 4.11 indicated significant influence of irrigation on harvest index during both the years and in pooled analysis. Significantly higher harvest index was recorded under treatment $I_4$, which was statistically at par with $I_3$ during both the years and in pooled data. The lower harvest index was recorded in treatment $I_1$, which was at par with treatment $I_2$ in individual years and in pooled analysis.

#### 4.2.9.2 Effect of weed management practices on harvest index

Data furnished in Table 4.11 indicated that harvest index was significantly higher recorded in $W_6$ treatment (11.02 %) which was at par with treatment $W_5$ (10.78 %), $W_1$ (10.20 %) and $W_2$ (10.01) during 2002-03. During 2003-04, same trend was noticed but $W_2$ (9.51 %) was not at par with treatment $W_6$. In pooled analysis, significantly higher harvest index was recorded in treatment $W_6$ (10.90 %) and was at par with only treatment $W_5$ (10.52 %).

#### 4.2.9.3 Interaction effect of I x W on harvest index

Interactive effect of irrigation schedules and weed management practices was found to be non-significant for harvest index.

### 4.2.10 Test weight (g/1000 seeds) at harvest

The mean data on test weight of dill seeds recorded at harvest are presented in Table 4.13 as affected by various irrigation schedules and weed management practices during the year 2002-03 and 2003-04 as well as pooled analysis.

#### 4.2.10.1 Effect of irrigation on test weight

Test weight (g 1000 $seed^{-1}$) recorded at harvest of dill seed was not significantly influenced by levels of irrigation during 2002-03 and 2003-04. Even though test weight recorded at harvest was significantly affected by irrigation treatments in pooled analysis. Significantly higher test weight was recorded in treatment $I_4$ (3.84 g), which was at par with $I_3$ (3.66 g) and $I_2$ (3.67 g) in pooled analysis.

### 4.2.10.2 Effect of weed management practices on test weight

Test weight of dill seed recorded at harvest was not significantly affected by various weed management practices during both the years and in pooled analysis. Even though higher test weight was 3.79 g, 3.76 g and 3.78 g. 1000 seeds$^{-1}$ were recorded in treatment $w_3$ in 2002-03, 2003-04 and in pooled analysis, respectively.

### 4.2.10.3 Interaction effect of I x W on test weight

The interaction effect of I x W on test weight was not observed during both the years and in pooled analysis.

**Table 4.13 : Effect of irrigation and weed management practices on test weight (g) at harvest**

| Treatments | Test weight ( g ) | | |
|---|---|---|---|
| | 2002-03 | 2003-04 | Pooled |
| **Irrigation (I)** | | | |
| $I_1$ | 3.64 | 3.60 | 3.62 |
| $I_2$ | 3.67 | 3.66 | 3.67 |
| $I_3$ | 3.68 | 3.64 | 3.66 |
| $I_4$ | 3.86 | 3.82 | 3.84 |
| S. Em. $\pm$ | 0.07 | 0.09 | 0.06 |
| C. D. at 5 % | NS | NS | 0.19 |
| C. V. % | 10.31 | 14.00 | 12.28 |
| **Weed management (W)** | | | |
| $W_1$ | 3.63 | 3.59 | 3.61 |
| $W_2$ | 3.64 | 3.59 | 3.61 |
| $W_3$ | 3.79 | 3.76 | 3.78 |
| $W_4$ | 3.64 | 3.60 | 3.62 |
| $W_5$ | 3.63 | 3.70 | 3.66 |
| $W_6$ | 3.75 | 3.65 | 3.70 |
| $W_7$ | 3.69 | 3.67 | 3.68 |
| S. Em. $\pm$ | 0.05 | 0.06 | 0.04 |
| C. D. at 5 % | NS | NS | NS |
| C. V. % | 5.91 | 6.96 | 6.46 |
| **Interaction** | NS | NS | NS |

## 4.3 QUALITY AND NUTRIENT CONTENT ANALYSIS IN DILL SEED

The detail studies of dill seed quality parameters *viz.,* oil content and nitrogen, phosphorus and potash content were analysed from dill seed collected at the time of harvest during the course of investigation are presented Tables 4.14 and 4.15.

### 4.3.1 Oil content (%) in dill seed

The mean data on oil content in dill seed influenced by irrigation schedules and weed management practices are presented in Table 4.14 during both the year 2002-03 and 2003-04 and pooled results.

#### 4.3.1.1 Effect of irrigation on oil content

The results presented in Table 4.14 showed the significant effect on oil content due to irrigation. Significantly the highest oil content was recorded under $I_3$ treatment during both the years (2.74 and 2.66 %) and in pooled results (2.70 %). Significantly lower oil content was observed in $I_1$ treatment, which was at par with treatment $I_2$ and $I_4$ during 2002-03 and 2003-04 as well as in pooled analysis.

#### 4.3.1.2 Effect of weed management practices on oil content

The evident of data presentation in Table 4.14 showed that the effect of weed management practices was found to be significant on oil content during 2003-04 and in pooled analysis. The effect was found non significant in oil content due to weed management practices during 2002-03. Significantly higher oil content was noticed with treatment $W_6$, which was at par with $W_1$ during 2003-04 and pooled analysis. Significantly lower oil content was recorded in treatment $W_7$, which was at par with treatment $W_2$, $W_1$, $W_3$, $W_5$ and $W_4$ during 2003-04 and in pooled analysis.

#### 4.3.1.3 Interaction effect of I x W on oil content

Oil content of dill seed was found to be non significantly due to interactive effect of irrigation schedules and weed management practices.

**Table 4.14 : Effect of irrigation and weed management practices on oil content (%) of dill seed at harvest**

| Treatments | Oil content (%) | | |
|---|---|---|---|
| | 2002-03 | 2003-04 | Pooled |
| **Irrigation (I)** | | | |
| $I_1$ | 2.56 | 2.46 | 2.51 |
| $I_2$ | 2.60 | 2.53 | 2.57 |
| $I_3$ | 2.74 | 2.66 | 2.70 |
| $I_4$ | 2.62 | 2.46 | 2.54 |
| S. Em. ± | 0.03 | 0.04 | 0.02 |
| C. D. at 5 % | 0.09 | 0.12 | 0.07 |
| C. V. % | 5.41 | 7.98 | 6.76 |
| **Weed management (W)** | | | |
| $W_1$ | 2.61 | 2.56 | 2.59 |
| $W_2$ | 2.58 | 2.46 | 2.52 |
| $W_3$ | 2.64 | 2.48 | 2.56 |
| $W_4$ | 2.59 | 2.48 | 2.53 |
| $W_5$ | 2.64 | 2.47 | 2.56 |
| $W_6$ | 2.73 | 2.63 | 2.68 |
| $W_7$ | 2.58 | 2.46 | 2.52 |
| S. Em. ± | 0.04 | 0.05 | 0.03 |
| C. D. at 5 % | NS | 0.14 | 0.09 |
| C. V. % | 5.70 | 7.91 | 6.85 |
| **Interaction** | NS | NS | NS |

### 4.3.2 Nutrient uptake by dill seed at harvest

The mean data on nutrient uptake *viz.,* N, $P_2O_5$ and $K_2O$ (kg $ha^{-1}$) by dill seed at harvest as influenced by various irrigation schedules and weed management practices are presented in Table 4.15 during the year 2002-03 and 2003-04 and pooled analysis.

#### 4.3.2.1 Effect of irrigation on nutrient uptake by dill seed

Analysis results of N, $P_2O_5$ and $K_2O$ in dill seed at harvest showed that irrigation schedules significantly enhanced the nutrient uptake by dill seed. The treatment $I_4$ recorded significantly the highest N, $P_2O_5$ and $K_2O$ uptake by seed during both the years and in pooled analysis. The lower uptake of N, $P_2O_5$ and $K_2O$ were recorded under treatment $I_1$ and it was at par with treatment $I_2$ during both the years and pooled analysis. It was further revealed that with increasing in irrigation levels, nutrient uptake was also increased.

#### 4.3.2.2 Effect of weed management practices on nutrient uptake by dill seed

A perusal of data presented in Table 4.15 showed that nutrient uptake by dill seed was significantly influenced by weed management practices at harvest. Treatment $W_6$ recorded significantly the highest nutrient uptake *viz.,* N, $P_2O_5$ and $K_2O$ by dill seed which was statistically differed than rest of the weed management practices. Treatment $W_1$ showed significantly higher nitrogen and phosphorus uptake which was at par with treatment $W_5$, while treatment $W_5$ showed significantly second higher potash uptake followed by treatment $W_1$ during both the years and in pooled results. Significantly the lowest N, $P_2O_5$ and $K_2O$ uptake were observed under the treatment $W_7$ during the year of 2002-03 and 2003-04 and in pooled analysis.

**Table 4.15 : Effect of irrigation and weed management practices on nutrient uptake by seeds (kg $ha^{-1}$) at harvest**

| Treatment | N | | | $P_2O_5$ | | | $K_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled |
| **Irrigation (I)** | | | | | | | | | |
| $I_1$ | 18.03 | 16.66 | 17.34 | 5.01 | 4.80 | 4.91 | 3.09 | 2.88 | 2.99 |
| $I_2$ | 19.11 | 17.19 | 18.15 | 5.47 | 5.04 | 5.26 | 3.22 | 2.96 | 3.09 |
| $I_3$ | 21.69 | 20.05 | 20.87 | 6.91 | 6.39 | 6.65 | 3.95 | 3.66 | 3.79 |
| $I_4$ | 24.85 | 23.22 | 24.03 | 7.65 | 7.16 | 7.41 | 4.37 | 4.09 | 4.23 |
| S. Em. ± | 0.64 | 0.57 | 0.43 | 0.21 | 0.18 | 0.14 | 0.09 | 0.07 | 0.06 |
| C. D. at 5 % | 2.06 | 1.82 | 1.28 | 0.66 | 0.58 | 0.41 | 0.30 | 0.21 | 0.17 |
| C. V. % | 16.27 | 15.27 | 15.99 | 17.47 | 16.30 | 16.94 | 13.74 | 10.23 | 12.26 |
| **Weed management (W)** | | | | | | | | | |
| $W_1$ | 29.01 | 26.08 | 27.55 | 8.82 | 8.16 | 8.49 | 4.77 | 4.39 | 4.58 |
| $W_2$ | 27.17 | 24.91 | 26.04 | 7.99 | 7.38 | 7.68 | 4.73 | 4.36 | 4.55 |
| $W_3$ | 15.25 | 14.11 | 16.68 | 4.50 | 4.17 | 4.34 | 2.91 | 2.68 | 2.80 |
| $W_4$ | 7.60 | 6.94 | 7.27 | 2.35 | 2.15 | 2.25 | 1.38 | 1.26 | 1.32 |
| $W_5$ | 28.43 | 26.07 | 27.25 | 8.15 | 7.72 | 7.93 | 5.16 | 4.76 | 4.96 |
| $W_6$ | 36.97 | 35.08 | 36.02 | 11.37 | 10.79 | 11.08 | 6.31 | 5.98 | 6.14 |
| $W_7$ | 2.03 | 1.76 | 1.89 | 0.68 | 0.58 | 0.63 | 0.35 | 0.30 | 0.33 |
| S. Em. ± | 1.00 | 0.94 | 0.69 | 0.27 | 0.22 | 0.17 | 0.14 | 0.12 | 0.09 |
| C. D. at 5 % | 2.83 | 2.65 | 1.92 | 0.77 | 0.61 | 0.49 | 0.41 | 0.32 | 0.26 |
| C. V. % | 19.17 | 19.49 | 19.34 | 17.46 | 14.77 | 16.28 | 15.70 | 13.55 | 14.75 |
| **Interaction** | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. |

**Table 4.16 : Interaction effect of irrigation (I)and weed management practices (W) on N uptake (kg ha$^{-1}$) by dill seed at harvest**

| Irrigation (I) | Weed management practices (W) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ | $W_6$ | $W_7$ |
| **2002-03** | | | | | | | |
| $I_1$ | 30.14 | 16.64 | 12.37 | 4.65 | 23.88 | 37.34 | 1.20 |
| $I_2$ | 27.25 | 24.80 | 12.74 | 5.59 | 30.29 | 31.14 | 1.98 |
| $I_3$ | 25.13 | 29.04 | 19.78 | 9.79 | 26.31 | 36.37 | 2.43 |
| $I_4$ | 30.52 | 38.20 | 16.11 | 10.37 | 33.22 | 43.02 | 2.51 |
| S. Em. ± | 2.00 | | | | | | |
| C. D. at 5 % | 5.66 | | | | | | |
| C. V. % | 19.17 | | | | | | |
| **2003-04** | | | | | | | |
| $I_1$ | 27.92 | 14.40 | 11.39 | 4.27 | 21.80 | 35.76 | 1.07 |
| $I_2$ | 22.36 | 22.85 | 11.75 | 5.07 | 27.18 | 29.39 | 1.70 |
| $I_3$ | 26.04 | 26.90 | 18.48 | 8.87 | 24.22 | 33.80 | 2.03 |
| $I_4$ | 28.01 | 35.48 | 14.81 | 9.55 | 31.07 | 41.38 | 2.24 |
| S. Em. ± | 1.88 | | | | | | |
| C. D. at 5 % | 5.30 | | | | | | |
| C. V. % | 19.49 | | | | | | |
| **Pooled** | | | | | | | |
| $I_1$ | 29.03 | 15.52 | 11.88 | 4.46 | 22.84 | 36.55 | 1.13 |
| $I_2$ | 24.81 | 23.82 | 12.24 | 5.33 | 28.74 | 30.26 | 1.84 |
| $I_3$ | 27.08 | 27.97 | 19.13 | 9.33 | 25.27 | 35.09 | 2.23 |
| $I_4$ | 29.27 | 36.84 | 15.46 | 9.96 | 32.14 | 42.20 | 2.38 |
| S. Em. ± | 1.37 | | | | | | |
| C. D. at 5 % | 3.83 | | | | | | |
| C. V. % | 19.34 | | | | | | |

**Table 4.17 : Interaction effect of irrigation (I) and weed management practices (W) on $P_2O_5$ uptake (kg $ha^{-1}$) by dill seed at harvest**

| Irrigation (I) | Weed management practices (W) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ | $W_6$ | $W_7$ |
| **2002-03** | | | | | | | |
| $I_1$ | 7.80 | 4.66 | 3.55 | 1.40 | 6.39 | 10.90 | 0.41 |
| $I_2$ | 6.63 | 8.59 | 3.60 | 1.59 | 9.23 | 8.02 | 0.66 |
| $I_3$ | 9.95 | 8.55 | 5.96 | 3.19 | 7.40 | 12.61 | 0.74 |
| $I_4$ | 10.90 | 10.16 | 4.91 | 3.22 | 9.57 | 13.94 | 0.89 |
| S. Em. ± | 0.58 | | | | | | |
| C. D. at 5 % | 1.54 | | | | | | |
| C. V. % | 17.46 | | | | | | |
| **2003-04** | | | | | | | |
| $I_1$ | 7.35 | 4.22 | 3.26 | 1.29 | 6.64 | 10.50 | 0.35 |
| $I_2$ | 6.06 | 7.94 | 3.35 | 1.46 | 8.49 | 7.46 | 0.57 |
| $I_3$ | 9.21 | 7.91 | 5.59 | 2.89 | 6.81 | 11.71 | 0.62 |
| $I_4$ | 10.01 | 9.45 | 4.48 | 2.95 | 8.95 | 13.48 | 0.80 |
| S. Em. ± | 0.43 | | | | | | |
| C. D. at 5 % | 1.22 | | | | | | |
| C. V. % | 14.77 | | | | | | |
| **Pooled** | | | | | | | |
| $I_1$ | 7.57 | 4.44 | 3.40 | 1.35 | 6.51 | 10.70 | 0.38 |
| $I_2$ | 6.34 | 8.27 | 3.47 | 1.52 | 8.86 | 7.74 | 0.61 |
| $I_3$ | 9.58 | 8.23 | 5.78 | 3.04 | 7.11 | 12.16 | 0.68 |
| $I_4$ | 10.45 | 9.81 | 4.70 | 3.08 | 9.26 | 13.71 | 0.85 |
| S. Em. ± | 0.35 | | | | | | |
| C. D. at 5 % | 0.97 | | | | | | |
| C. V. % | 16.28 | | | | | | |

**Table 4.18 : Interaction effect of irrigation (I) and weed management practices (W) on $K_2O$ uptake (kg $ha^{-1}$) by dill seed at harvest**

| Irrigation (I) | Weed management practices (W) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ | $W_6$ | $W_7$ |
| **2002-03** | | | | | | | |
| $I_1$ | 4.09 | 2.86 | 2.60 | 0.67 | 4.38 | 6.82 | 0.23 |
| $I_2$ | 4.78 | 4.57 | 2.33 | 1.14 | 5.15 | 4.24 | 0.34 |
| $I_3$ | 4.60 | 4.61 | 3.65 | 1.71 | 5.61 | 7.10 | 0.37 |
| $I_4$ | 5.62 | 6.90 | 3.05 | 1.99 | 5.50 | 7.06 | 0.46 |
| S. Em. ± | 0.29 | | | | | | |
| C. D. at 5 % | 0.81 | | | | | | |
| C. V. % | 15.70 | | | | | | |
| **2003-04** | | | | | | | |
| $I_1$ | 3.77 | 2.59 | 2.39 | 0.62 | 4.03 | 6.55 | 0.21 |
| $I_2$ | 4.38 | 4.21 | 2.16 | 1.04 | 4.73 | 3.98 | 0.30 |
| $I_3$ | 4.25 | 4.23 | 3.41 | 1.56 | 5.14 | 6.56 | 0.31 |
| $I_4$ | 5.17 | 6.44 | 2.79 | 1.83 | 5.15 | 6.87 | 0.41 |
| S. Em. ± | 0.23 | | | | | | |
| C. D. at 5 % | 0.65 | | | | | | |
| C. V. % | 13.55 | | | | | | |
| **Pooled** | | | | | | | |
| $I_1$ | 3.93 | 2.72 | 2.49 | 0.65 | 4.21 | 6.69 | 0.22 |
| $I_2$ | 4.58 | 4.39 | 2.24 | 1.09 | 4.94 | 4.09 | 0.32 |
| $I_3$ | 4.43 | 4.42 | 3.53 | 1.63 | 5.37 | 6.83 | 0.34 |
| $I_4$ | 5.39 | 6.67 | 2.92 | 1.91 | 5.33 | 6.96 | 0.43 |
| S. Em. ± | 0.18 | | | | | | |
| C. D. at 5 % | 0.51 | | | | | | |
| C. V. % | 14.75 | | | | | | |

### 4.3.2.3 Interaction effect of I x W on nutrient uptake by dill seed

The interaction effect of irrigation schedules and weed management practices was significant for N, $P_2O_5$ and $K_2O$ uptake by dill seed during both the years and in pooled analysis.

**Nitrogen (N) uptake**

Interaction effect of I x W on N uptake in dill seed during 2002-03, 2003-04 and in pooled analysis is presented in Table 4.16. Significantly the higher N uptake was recorded by treatment combination of $I_4W_6$ during both the years and in pooled analysis, which was not differed to $I_4W_2$ during 2002-03. The lower uptake of nitrogen by dill seed was observed by combination of $I_1W_7$, which remained at par with $I_2W_7$, $I_3W_7$, $I_4W_7$, $I_1W_4$ and $I_2W_4$ during both the years and in pooled analysis.

**$P_2O_5$ uptake**

It is evident from the data presented in Table 4.17 that interaction of irrigation schedules and weed management practices found to be significant during both the years and in pooled analysis.

Treatment combination $I_4W_6$ recorded significantly the highest $P_2O_5$ uptake by dill seed during both the (13.94 and 13.48 kg $ha^{-1}$) years and in pooled analysis (13.71 kg $ha^{-1}$), which was statistically not differed with $I_3W_6$ (12.61 kg $ha^{-1}$) during 2002-03. Treatment combination $I_1W_7$ recorded significantly lower $P_2O_5$ uptake by dill seed at harvest, which was statistically at par with $I_2W_7$, $I_3W_7$, $I_4W_7$ and $I_1W_4$ and $I_2W_4$.

**$K_2O$ uptake**

A perusal of data presented in Table 4.18 indicated the interaction effect of irrigation and weed management practices during both the years and in pooled analysis. During 2002-03, significantly maximum $K_2O$ uptake was observed in combination of $I_3W_6$ (7.10 kg $ha^{-1}$) which was statistically not differed with $I_4W_6$, $I_4W_2$, and $I_1W_6$. Treatment combination $I_4W_6$ removed significantly higher $K_2O$ content by dill seed during 2003-04 (6.87 kg $ha^{-1}$) and in pooled analysis (6.96 kg $ha^{-1}$) which was statistically at par with $I_3W_4$, $I_1W_6$, and $I_4W_2$ during 2003-04 and in pooled analysis. The minimum $K_2O$ uptake was recorded under $I_1W_7$ which was statistically at par with $I_2W_7$, $I_3W_7$ $I_4W_7$ and $I_1W_4$ during both the years and in pooled analysis.

**4.3.3 Nutrient uptake by straw of dill seed at harvest**

Data cited in Table 4.19 showed the effect of irrigation schedules and weed management practices as well as effect of I x W on nutrient uptake *viz.,* N, $P_2O_5$ and $K_2O$ (kg $ha^{-1}$) by straw of dill seed at harvest.

**4.3.3.1 Effect of irrigation on nutrient uptake by straw**

A critical examination of data presented in Table 4.19 indicated that the significant influence of irrigation schedules on N and $K_2O$ uptake by straw but uptake of $P_2O_5$ was not significantly influence by straw at harvest. It was further revealed that nutrient uptake was increased with increasing in irrigation levels. The highest N and $K_2O$ uptake by straw at harvest was recorded with treatment $I_4$, while the lower uptake of N and $P_2O_5$ were under $I_1$ during both the years and in pooled analysis.

#### 4.3.3.2 Effect of weed management practices on nutrient uptake by straw

Nutrient uptake by straw of dill seed as influenced by different weed management practices was significant during both the years and in pooled analysis (Table 4.19). Treatment $W_6$ recorded significantly the highest N, $P_2O_5$ and $K_2O$ uptake while the lowest value was observed with treatment $W_7$ during both the years and in pooled analysis.

#### 4.3.3.3 Interaction effect of I x W on nutrient uptake by straw

The interaction effect of irrigation and weed management practices was significant for $P_2O_5$ uptake by straw during both the years and in pooled analysis, while N and $K_2O$ uptake by straw was non-significant due to interactive effect of I x W.

Significantly the maximum $P_2O_5$ uptake (Table 4.20) was noticed under $I_2W_1$ during 2002-03, which was statistically at par with $I_4W_6$, $I_3W_6$, $I_2W_6$, $I_3W_2$, $I_2W_5$, $I_3W_3$ $I_4W_3$, $I_4W_1$ and $I_3W_5$. During 2003-04 and in pooled analysis $I_4W_6$ showed significantly higher $P_2O_5$ uptake by straw which was statistically at par with combination of $I_2W_1$, $I_3W_6$, $I_2W_5$, $I_3W_2$, $I_1W_6$ and $I_2W_6$. The lower $P_2O_5$ uptake was recorded with treatment combination of $I_2W_7$ during 2002-03 and $I_1W_7$ during 2003-04 and in pooled analysis which was at par with $I_3W_7$ and $I_4W_7$.

Table 4.19 : Effect of irrigation and weed management practices on nutrient uptake by straw (kg $ha^{-1}$) at harvest

| Treatment | N | | | $P_2O_5$ | | | $K_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled |
| **Irrigation (I)** | | | | | | | | | |
| $I_1$ | 65.27 | 61.84 | 63.56 | 24.91 | 23.12 | 24.02 | 65.51 | 61.81 | 63.66 |
| $I_2$ | 70.39 | 65.49 | 67.94 | 27.23 | 25.44 | 26.33 | 66.74 | 63.73 | 65.24 |
| $I_3$ | 72.57 | 70.05 | 71.31 | 28.39 | 27.26 | 27.82 | 70.81 | 68.01 | 69.41 |
| $I_4$ | 82.48 | 78.70 | 80.59 | 27.93 | 26.81 | 27.37 | 76.79 | 73.55 | 75.17 |
| S. Em. ± | 2.23 | 19.60 | 1.48 | 1.12 | 1.08 | 0.78 | 1.07 | 1.39 | 0.88 |
| C. D. at 5 % | 7.12 | 6.27 | 4.40 | NS | NS | NS | 3.42 | 4.45 | 2.61 |
| C. V. % | 16.10 | 15.03 | 15.67 | 21.83 | 22.32 | 22.07 | 8.09 | 11.03 | 9.60 |
| **Weed management (W)** | | | | | | | | | |
| $W_1$ | 88.04 | 85.53 | 86.78 | 31.65 | 30.50 | 31.08 | 89.24 | 85.74 | 87.49 |
| $W_2$ | 80.64 | 77.67 | 79.15 | 29.97 | 28.40 | 29.19 | 80.55 | 76.71 | 78.63 |
| $W_3$ | 72.14 | 67.70 | 69.92 | 31.24 | 29.51 | 30.37 | 75.31 | 70.99 | 73.15 |
| $W_4$ | 53.32 | 49.93 | 51.62 | 22.66 | 20.78 | 21.72 | 51.58 | 48.88 | 50.23 |
| $W_5$ | 86.22 | 83.04 | 84.63 | 32.81 | 31.16 | 31.9 | 82.70 | 79.18 | 80.94 |
| $W_6$ | 115.89 | 107.27 | 111.58 | 36.85 | 34.79 | 35.82 | 97.86 | 93.82 | 95.84 |
| $W_7$ | 12.49 | 11.98 | 12.24 | 4.61 | 4.44 | 4.53 | 12.51 | 12.10 | 12.30 |
| S. Em. ± | 3.42 | 3.11 | 2.31 | 1.52 | 1.25 | 0.99 | 2.68 | 2.06 | 1.69 |
| C. D. at 5 % | 9.66 | 8.78 | 6.45 | 4.28 | 3.55 | 2.75 | 7.57 | 5.83 | 4.72 |
| C. V. % | 18.84 | 18.04 | 18.47 | 22.39 | 19.61 | 21.13 | 15.33 | 12.37 | 14.00 |
| **Interaction** | NS | NS | NS | Sig. | Sig. | Sig. | NS | NS | NS |

**Table 4.20 : Interaction effect of irrigation (I) and weed management practices (W) on $P_2O_5$ uptake (kg $ha^{-1}$) by straw of dill seed at harvest**

| Irrigation (I) | Weed management practices (W) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ | $W_6$ | $W_7$ |
| **2002-03** | | | | | | | |
| $I_1$ | 28.92 | 23.20 | 33.26 | 22.44 | 29.50 | 33.64 | 3.41 |
| $I_2$ | 39.91 | 30.12 | 26.55 | 17.45 | 36.73 | 36.45 | 3.37 |
| $I_3$ | 25.19 | 36.47 | 35.69 | 26.67 | 31.90 | 37.45 | 5.75 |
| $I_4$ | 32.60 | 30.11 | 29.46 | 24.07 | 33.11 | 39.87 | 6.32 |
| S. Em. ± | 3.04 | | | | | | |
| C. D. at 5 % | 8.57 | | | | | | |
| C. V. % | 22.39 | | | | | | |
| **2003-04** | | | | | | | |
| $I_1$ | 27.51 | 21.85 | 31.08 | 17.94 | 28.05 | 32.29 | 3.14 |
| $I_2$ | 38.49 | 28.59 | 24.25 | 16.67 | 35.07 | 31.69 | 3.33 |
| $I_3$ | 24.45 | 34.82 | 34.07 | 25.42 | 30.25 | 36.49 | 5.31 |
| $I_4$ | 31.56 | 28.33 | 28.64 | 23.11 | 31.29 | 38.71 | 6.00 |
| S. Em. ± | 2.52 | | | | | | |
| C. D. at 5 % | 7.10 | | | | | | |
| C. V. % | 19.61 | | | | | | |
| **Pooled** | | | | | | | |
| $I_1$ | 28.22 | 22.53 | 32.17 | 20.19 | 28.77 | 32.97 | 3.28 |
| $I_2$ | 39.20 | 29.36 | 25.40 | 17.06 | 35.90 | 34.07 | 3.35 |
| $I_3$ | 24.82 | 35.64 | 34.88 | 26.05 | 31.08 | 36.97 | 5.33 |
| $I_4$ | 32.08 | 29.22 | 29.05 | 23.59 | 32.20 | 39.29 | 6.16 |
| S. Em. ± | 1.97 | | | | | | |
| C. D. at 5 % | 5.50 | | | | | | |
| C. V. % | 21.13 | | | | | | |

## 4.4 WATER USE EFFICIENCY (%)

A keen observation of data presented in Table 4.21 indicate the effect of irrigation and weed management practices on water use efficiency (%) recorded during the year of 2002-03 and 2003-04 and pooled analysis.

### 4.4.1 Effect of irrigation on water use efficiency

Data presented in Table 4.21 clearly showed that water use efficiency was significantly affected due to various irrigation schedules. With the increasing in the irrigation levels, the water use efficiency was decreased. Significantly the highest water use efficiency was observed under treatment $I_1$ which was 6.94 %, and 6.49 % and 6.70 % during 2002-03, 2003-04 and pooled analysis, respectively. Treatment $I_4$ noticed significantly lower water use efficiency during both the years and in pooled results which was remained at par with $I_3$ during 2002-03 and 2003-04.

### 4.4.2 Effect of weed management practices

Data tabulated in Table 4.21 clearly revealed that the water use efficiency was significantly influenced due to different weed management practices. The maximum water use efficiency was noticed with treatment $W_6$ which was significantly highest among all the weed management practices during both the years and in pooled analysis. while, minimum water use efficiency was recorded under treatment $W_7$ during both the years and in pooled analysis. Which was significantly lowest recorded than rest of the weed management practices.

### 4.4.3 Interaction effect I x W on water use efficiency

Water use efficiency was significantly affected by interaction of irrigation schedules and weed management practices (Table 4.22). The treatment combination $I_1W_6$ recorded significantly the highest water use efficiency during both the years and in pooled analysis. The lower value of water use efficiency was noticed with treatment combination $I_4W_7$ but remained at par with $I_3W_7$, $I_1W_7$ and $I_2W_7$ during the year 2003-04 and in pooled analysis and it was also at par with $I_2W_4$ and $I_1W_4$ during 2002-03.

**Table 4.21 : Effect of irrigation and weed management practices on water use efficiency (%)**

| Treatments | Water use efficiency (%) | | |
|---|---|---|---|
| | 2002-03 | 2003-04 | Pooled |
| **Irrigation (I)** | | | |
| $I_1$ | 6.94 | 6.46 | 6.70 |
| $I_2$ | 5.62 | 5.17 | 5.39 |
| $I_3$ | 5.30 | 4.91 | 5.11 |
| $I_4$ | 5.03 | 4.70 | 4.86 |
| S. Em. ± | 0.09 | 0.09 | 0.06 |
| C. D. at 5 % | 0.30 | 0.30 | 0.20 |
| C. V. % | 8.78 | 9.27 | 9.02 |
| **Weed management (W)** | | | |
| $W_1$ | 8.29 | 7.63 | 7.96 |
| $W_2$ | 7.15 | 6.59 | 6.87 |
| $W_3$ | 4.01 | 3.72 | 3.87 |
| $W_4$ | 1.99 | 1.83 | 1.91 |
| $W_5$ | 8.05 | 7.43 | 7.74 |
| $W_6$ | 9.98 | 9.46 | 9.72 |
| $W_7$ | 0.57 | 0.49 | 0.53 |
| S. Em. ± | 0.22 | 0.16 | 0.13 |
| C. D. at 5 % | 0.61 | 0.45 | 0.37 |
| C. V. % | 15.19 | 11.96 | 13.80 |
| **Interaction** | Sig. | Sig. | Sig. |

**Table 4.22 : Interaction effect of irrigation (I) and weed management practices (W) on water use efficiency during 2002-03, 2003-04 and pooled analysis**

| Irrigation (I) | Weed management practices (W) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ | $W_6$ | $W_7$ |
| **2002-03** | | | | | | | |
| $I_1$ | 10.66 | 6.36 | 7.42 | 1.65 | 9.85 | 14.78 | 0.56 |
| $I_2$ | 8.74 | 8.29 | 3.44 | 1.62 | 8.82 | 7.77 | 0.65 |
| $I_3$ | 7.06 | 6.38 | 4.48 | 2.45 | 6.88 | 9.34 | 0.56 |
| $I_4$ | 6.71 | 7.57 | 3.43 | 2.28 | 6.64 | 8.06 | 0.52 |
| S. Em. ± | 0.43 | | | | | | |
| C. D. at 5 % | 1.22 | | | | | | |
| C. V. % | 15.19 | | | | | | |
| **2003-04** | | | | | | | |
| $I_1$ | 9.83 | 5.76 | 4.35 | 1.53 | 9.06 | 14.20 | 0.50 |
| $I_2$ | 7.99 | 7.65 | 3.20 | 1.48 | 8.09 | 7.21 | 0.56 |
| $I_3$ | 6.54 | 5.92 | 4.20 | 2.22 | 6.35 | 8.66 | 0.47 |
| $I_4$ | 6.17 | 7.05 | 3.13 | 2.08 | 6.21 | 7.79 | 0.46 |
| S. Em. ± | 0.31 | | | | | | |
| C. D. at 5 % | 0.89 | | | | | | |
| C. V. % | 11.96 | | | | | | |
| **Pooled** | | | | | | | |
| $I_1$ | 10.25 | 6.06 | 4.54 | 1.59 | 9.45 | 14.49 | 0.53 |
| $I_2$ | 8.36 | 7.97 | 3.32 | 1.55 | 8.46 | 7.49 | 0.60 |
| $I_3$ | 6.80 | 6.15 | 4.34 | 2.33 | 6.61 | 8.99 | 0.51 |
| $I_4$ | 6.44 | 7.31 | 3.28 | 2.18 | 6.43 | 7.92 | 0.49 |
| S. Em. ± | 0.27 | | | | | | |
| C. D. at 5 % | 0.75 | | | | | | |
| C. V. % | 13.80 | | | | | | |

## 4.5 STUDIES ON WEEDS

### 4.5.1 Weed flora of the experimental field

The details of weed flora observed in the experimental field (weedy check) are given in Table 4.23 according to their family, botanical name, English name and local name.

**Table 4.23 : Weed flora in experimental field**

| Family | Botanical name | English name | Local name |
|---|---|---|---|
| **Monocot weeds** | | | |
| Cyperaceae | *Cyperus rotundus* L. | Purple-nut sedge | *Chidho* |
| Poaceae | *Eragrostis major* Host. | Love grass | *Bhumsi* |
| Poaceae | *Eleusine indica* Gaertn. | Goose grass | *Chokhaliu* |
| Poaceae | *Dactyloctenium aegyptium* L. | Wild finger | *Chokadiu* |
| **Dicot weeds** | | | |
| Euphorbiaceae | *Phyllanthus niruri* L. | Gripe weed | *Bhoi amli* |
| Liliaceae | *Asphodelus tenuifolius* Cav. | Wild onion | *Dungro* |
| Purslane | *Portulaca oleracea* L. | Purslane | *Luni* |
| Leguminoceae | *Melilotus indica* L. | Yellow sweet clover | *Methiu* |
| Chenopodiaceae | *Chenopodium murale* L. | Nettle leaf, goose foot | *Chill-bilado* |
| Chenopodiaceae | *Chenopodium album* L. | Lamb's quarters | *Chill* |

### 4.5.2 Weed density recorded at various intervals

#### 4.5.2.1 Weed density recorded at 3 WAS

Mean data on weed population (No. $m^{-2}$) recorded at 3 WAS as affected by irrigation schedules and weed management practices are presented in Table 4.24 of the year 2002-03 and 2003-04 and in pooled analysis.

*Plate 4.1* : Weed flora in the experimental plot

#### 4.5.2.1.1 Effect of irrigation on weed counts

An appraisal of the data presented in Table 4.24 revealed that the monocot, dicot and total weed counts recorded at 3 WAS were not significantly influenced by the irrigation schedules during both the years and in pooled analysis. In other words, all the irrigation treatments were statistically at par in respect to weed density at initial stage.

#### 4.5.2.1.2 Effect of weed management practices on weed counts

A close examination of data presented in Table 4.24 showed significant influence of weed management practices on weed counts during both the years and in pooled analysis. Weed counts *viz.*, monocot, dicot and total weeds were significantly highest recorded in treatment $W_7$ (Weedy check). While $W_6$ (HW at 3 and 6 WAS) showed significantly lower weed counts which was at par with $W_5$ (HW at 3 WAS and earthing up at 6 WAS) during the year of 2002-03 and 2003-04 and in pooled analysis.

Among herbicidal treatments, $W_1$ (fluchloralin 1.0 kg $ha^{-1}$ as PE) recorded the minimum weed counts of monocot, dicot and total during both the years and in pooled analysis. The maximum weed counts of dicot and total weeds were recorded under treatments $W_3$ (metolachlor 1.0 kg $ha^{-1}$ as PE) among herbicidal treatments, which was followed by $W_4$ (oxadiargyl 100 g $ha^{-1}$ as PE).

As is evident from the Table 4.24, each weed management treatment influenced the total number of weeds significantly in pooled analysis. Treatment $W_7$ (Weedy check) was responsible for the highest number of total weeds followed by $W_3$, $W_4$, $W_2$ and $W_1$ in decreasing order of mean magnitude.

**Table 4.24 : Effect of irrigation and weed management practices on weed counts (No. $m^{-2}$) at 3 WAS**

| Treatments | Monocot | | | Dicot | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled |
| **Irrigation (I)** | | | | | | | | | |
| $I_1$ | 2.41 (6.9)* | 2.45 (7.3) | 2.44 (7.1) | 9.06 (131.3) | 8.89 (128.9) | 8.99 (130.1) | 9.34 (138.4) | 9.34 (136.2) | 9.27 (137.3) |
| $I_2$ | 2.45 (7.3) | 2.46 (7.4) | 2.51 (7.3) | 8.85 (129.5) | 9.34 (144.2) | 9.10 (136.9) | 9.15 (137.3) | 9.18 (151.5) | 9.40 (144.4) |
| $I_3$ | 2.37 (6.8) | 2.46 (7.4) | 2.42 (7.1) | 8.80 (127.2) | 9.14 (136.8) | 8.97 (132.0) | 9.10 (134.0) | 9.07 (144.1) | 9.25 (139.0) |
| $I_4$ | 2.38 (6.9) | 2.49 (7.4) | 2.43 (7.1) | 8.74 (129.2) | 9.93 (132.2) | 8.86 (130.7) | 9.09 (136.1) | 9.06 (139.6) | 9.15 (138.4) |
| S. Em. ± | 0.03 | 0.02 | 0.01 | 0.06 | 0.18 | 0.08 | 0.06 | 0.06 | 0.08 |
| C.D. at 5 % | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| C.V. % | 6.4 | 3.54 | 3.15 | 3.6 | 10.4 | 4.74 | 3.9 | 4.9 | 4.5 |
| **Weed management (W)** | | | | | | | | | |
| $W_1$ | 2.29 (5.9) | 2.48 (5.6) | 2.49 (5.8) | 6.65 (43.8) | 6.76 (45.3) | 0.71 (44.5) | 7.06 (49.6) | 7.08 (50.9) | 7.12 (50.3) |
| $W_2$ | 2.59 (6.3) | 2.63 (6.4) | 2.61 (6.3) | 7.19 (51.4) | 7.54 (56.5) | 7.38 (56.0) | 7.63 (57.7) | 7.62 (62.9) | 7.79 (60.0) |
| $W_3$ | 2.75 (7.6) | 2.88 (7.8) | 2.86 (7.7) | 15.36 (235.6) | 15.46 (238.7) | 15.41 (273.1) | 15.61 (243.0) | 15.60 (246.5) | 15.66 (245.0) |
| $W_4$ | 2.87 (8.0) | 2.98 (5.6) | 2.96 (8.3) | 9.51 (90.3) | 9.73 (94.3) | 9.63 (92.3) | 9.94 (98.0) | 9.42 (102.9) | 10.05 (101.0) |
| $W_5$ | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) |
| $W_6$ | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) |
| $W_7$ | 4.70 (21.06) | 4.86 (23.0) | 4.82 (22.0) | 22.00 (448.0) | 22.6 (513.8) | 22.32 (499.0) | 22.52 (506.4) | 24.51 (536.9) | 22.83 (523.0) |
| S. Em. ± | 0.04 | 0.03 | 0.03 | 0.07 | 0.19 | 0.11 | 0.07 | 0.07 | 0.11 |
| C.D. at 5 % | 0.12 | 0.09 | 0.08 | 0.20 | 0.53 | 0.30 | 0.19 | 0.19 | 0.30 |
| C.V. % | 7.2 | 5.15 | 4.4 | 3.17 | 8.34 | 4.8 | 2.95 | 3.0 | 4.6 |
| **Interaction** | NS | NS | NS | NS | NS | NS | NS | NS | NS |

($\sqrt{X + 0.5}$ transformed values); * Figures in parentheses are original value

**4.5.2.1.3 Interaction effect of I x W on weed counts**

Interaction of irrigation schedules and weed management practices was not significant for monocot, dicot and total weeds during 2002-03, 2003-04 and in pooled analysis.

**4.5.2.2 Weed density recorded at 6 WAS**

Weed counts recorded at 6 WAS in dill seed crop *viz.,* monocot, dicot and total weeds as influenced by different irrigation schedules and weed management practices are presented in Table 4.25.

**4.5.2.2.1 Effect of irrigation on weed counts**

It was observed from the data given in Table 4.25 that the differences in monocot, dicot and total weeds during the year 2002-03 and 2003-04 and in pooled analysis were not significant due to irrigation schedules.

**4.5.2.2.2 Effect of weed management practices on weed counts**

The results presented in Table 4.25 revealed that monocot, dicot and total weed counts per square meter were significantly influenced by different weed management practices at 6 WAS during both the years and in pooled analysis. Significantly the lowest weed counts were recorded under treatment $W_6$ (HW at 3 and 6 WAS) followed by $W_5$ (HW at 3 WAS and earthing up at 6 WAS). Among chemical weed control treatments, significantly superiority was observed under $W_1$ in respect of monocot (7.6 $m^{-2}$), dicot (46.4 $m^{-2}$) and total (54.0 $m^{-2}$) weed counts than the rest of the herbicidal treatments *viz.,* $W_2$, $W_3$ and $W_4$ during 2002-03, 2003-04 and pooled analysis, respectively. Treatment $W_7$ (Weedy check) registered significantly the highest weed counts of monocot, dicot and total weeds during both the years and in pooled analysis.

**Table 4.25 : Effect of irrigation and weed management practices on weed counts (No. m$^{-2}$) at 6 WAS**

| Treatments | Monocot | | | Dicot | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled |
| **Irrigation (I)** | | | | | | | | | |
| $I_1$ | 3.20 (11.6) | 3.33 (12.5) | 3.27 (12.0) | 9.95 (139.8) | 10.00 (148.0) | 10.03 (143.9) | 10.43 (151.4) | 10.63 (160.5) | 10.54 (155.9) |
| $I_2$ | 3.25 (12.0) | 3.40 (13.0) | 3.33 (12.5) | 9.78 (138.6) | 9.95 (142.7) | 9.47 (140.7) | 10.30 (150.6) | 10.51 (155.8) | 10.41 (153.2) |
| $I_3$ | 3.36 (13.0) | 3.48 (13.5) | 3.42 (13.2) | 9.75 (139.6) | 10.09 (148.5) | 9.92 (144.0) | 10.31 (152.5) | 10.68 (162.0) | 10.50 (157.3) |
| $I_4$ | 3.29 (2.3) | 3.40 (13.0) | 3.35 (12.6) | 9.96 (145.0) | 9.85 (141.4) | 9.91 (143.2) | 10.48 (157.3) | 10.42 (154.4) | 10.46 (155.8) |
| S. Em. ± | 0.04 | 0.05 | 0.04 | 0.07 | 0.13 | 0.06 | 0.07 | 0.13 | 0.06 |
| C.D. at 5 % | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| C.V. % | 6.7 | 7.4 | 6.24 | 3.5 | 7.0 | 3.28 | 3.42 | 6.8 | 3.28 |
| **Weed management (W)** | | | | | | | | | |
| $W_1$ | 2.75 (7.1) | 2.93 (8.1) | 2.84 (7.6) | 6.85 (46.5) | 6.45 (46.4) | 6.35 (46.4) | 7.35 (53.6) | 4.41 (54.5) | 7.39 (54.0) |
| $W_2$ | 3.54 (12.1) | 3.76 (13.7) | 3.65 (12.9) | 7.47 (55.4) | 7.63 (57.9) | 7.56 (56.6) | 8.24 (67.5) | 8.48 (71.5) | 8.37 (69.5) |
| $W_3$ | 3.90 (14.7) | 4.08 (16.2) | 3.99 (15.5) | 15.69 (246.1) | 15.57 (242.0) | 15.62 (244.0) | 16.16 (260.9) | 16.08 (285.2) | 16.12 (259.5) |
| $W_4$ | 4.21 (17.3) | 4.41 (19.0) | 4.31 (18.2) | 10.06 (101.2) | 9.98 (99.0) | 10.03 (100.0) | 10.89 (118.5) | 10.89 (118.3) | 10.90 (118.4) |
| $W_5$ | 2.44 (5.5) | 2.66 (6.6) | 2.55 (6.1) | 5.82 (33.4) | 6.18 (37.8) | 6.00 (35.6) | 6.27 (38.9) | 6.69 (44.4) | 6.49 (41.7) |
| $W_6$ | 0.71 (0.0) | 0.71 (0.0) | 0.71 (0.0) | 0.71 (0.0) | 0.71 (0.0) | 0.71 (0.0) | 0.71 (0.0) | 0.71 (0.0) | 0.71 (0.0) |
| $W_7$ | 5.38 (28.6) | 5.29 (27.5) | 5.34 (28.1) | 22.41 (502.5) | 23.08 (532.8) | 22.76 (518.0) | 23.05 (531.1) | 23.67 (560.3) | 23.37 (546.0) |
| S. Em. ± | 0.06 | 0.05 | 0.05 | 0.11 | 0.09 | 0.07 | 0.10 | 0.08 | 0.06 |
| C.D. at 5 % | 0.17 | 0.14 | 0.14 | 0.30 | 0.24 | 0.19 | 0.27 | 0.24 | 0.18 |
| C.V. % | 7.5 | 6.0 | 5.9 | 4.3 | 3.46 | 2.74 | 6.3 | 3.13 | 2.41 |
| Interaction | NS | NS | NS | NS | NS | NS | NS | NS | NS |

($\sqrt{X + 0.5}$ transformed values) * Figures in parentheses are original value

**4.5.2.2.3 Interaction effect of I x W on weed counts**

The interaction effect of different irrigation schedules and weed management practices in respect to weed counts recorded at 6 WAS were found to be non significant during 2002-03 and 2003-04 as well as in pooled analysis.

**4.5.2.3 Weed density recorded at harvest**

Data pertaining to number of weeds recorded at harvest as influenced by different irrigation schedules and weed management measures are presented in Table 4.26 during the year 2002-03 and 2003-04 and in pooled analysis.

**4.5.2.3.1 Effect of irrigation on weed counts**

Data cited in Table 4.26 showed that there was no any significant changes recorded in monocot, dicot and total weeds due to various irrigation schedules during both the years and in pooled data.

**4.5.2.3.2 Effect of weed management practices on weed counts**

A keen observation of data presented in Table 4.26 indicated significant influence of weed management practices on monocot, dicot and total weed counts (No. $m^{-2}$) during both the years and in pooled analysis. Significantly the highest weed counts were observed with treatment $W_7$ (Weedy check). While, significantly the lowest weed counts recorded with treatment $W_6$ (HW at 3 and 6 WAS) during both the years and in pooled analysis for monocot, dicot and total weed counts recorded at harvest. Treatment $W_5$ (HW at 3 WAS and earthing up at 6 WAS) stood second best treatment for controlling monocot and dicot weeds at harvest. Among chemical weed control treatments, $W_2$ (pendimethalin 1.0 kg $ha^{-1}$ as PE) showed minimum total weed counts at harvest during both the years and in pooled analysis. However, it was at par with $W_1$ (fluchloralin 1.0 kg $ha^{-1}$, PE) in respect to control weeds at the stage of harvest.

**Table 4.26 : Effect of irrigation and weed management practices on weed counts (No. $m^{-2}$ )at harvest**

| Treatments | Monocot | | | Dicot | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled |
| **Irrigation (I)** | | | | | | | | | |
| $I_1$ | 2.53 (6.50) | 2.58 (6.79) | 2.25 (6.64) | 6.95 58.25 | 7.17 (61.39) | 7.06 (59.82) | 7.42 (64.75) | 10.17 (123.00) | 8.90 (93.88)* |
| $I_2$ | 2.56 (6.75) | 2.66 (7.21) | 2.61 (6.98) | 6.85 59.96 | 7.10 (60.36) | 6.97 (58.66) | 7.34 (63.71) | 10.04 (120.68) | 8.80 (92.20) |
| $I_3$ | 2.75 (6.79) | 2.62 (7.07) | 2.60 (6.93) | 7.41 65.96 | 7.34 (63.18) | 7.41 (64.57) | 7.88 (72.75) | 10.81 (138.71) | 9.46 105.73 |
| $I_4$ | 2.54 (6.57) | 2.68 (7.32) | 2.61 (6.95) | 6.86 56.46 | 7.10 (60.25) | 6.98 (58.36) | 7.34 (63.04) | 10.05 (119.50) | 8.00 (91.27) |
| S. Em. ± | 0.02 | 0.03 | 0.02 | 0.17 | 0.03 | 0.10 | 0.16 | 0.23 | 0.20 |
| C.D. at 5 % | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| C.V. % | 5.16 | 5.10 | 4.5 | 12.62 | 2.5 | 7.6 | 7.6 | 11.83 | 11.59 |
| **Weed management (W)** | | | | | | | | | |
| $W_1$ | 2.3 (5.31) | 2.37 (5.63) | 2.34 (5.74) | 5.56 36.13 | 5.20 (27.13) | 5.44 (31.63) | 5.44 (31.63) | 8.22 (77.56) | 7.71 (59.50) |
| $W_2$ | 2.54 (6.50) | 2.65 (7.06) | 2.60 (6.78) | 5.58 32.31 | 5.96 (35.50) | 3.82 (33.91) | 5.82 (33.91) | 8.43 (71.13) | 7.41 (54.97) |
| $W_3$ | 2.76 (7.63) | 2.86 (8.19) | 2.81 (7.91) | 6.09 37.13 | 6.36 (40.50) | 6.23 (38.81) | 6.23 (38.81) | 9.04 (81.88) | 7.95 (63.31) |
| $W_4$ | 2.88 (8.33) | 2.98 (8.88) | 2.93 (8.59) | 7.53 56.75 | 7.75 (60.13) | 7.63 (58.44) | 7.63 (58.44) | 11.03 (121.81) | 9.66 (93.44) |
| $W_5$ | 2.38 (5.69) | 2.47 (6.13) | 2.42 (5.19) | 5.33 28.50 | 5.60 (31.44) | 5.47 (29.97) | 5.47 (29.97) | 7.91 (62.69) | 6.96 (48.44) |
| $W_6$ | 1.93 (3.75) | 1.98 (3.94) | 1.96 (3.84) | 4.64 21.56 | 8.44 (23.56) | 4.74 (22.56) | 4.74 (22.56) | 6.84 (46.88) | 6.00 (36.09) |
| $W_7$ | 3.06 (9.38) | 3.14 (9.88) | 3.10 (9.63) | 14.26 203.5 | 14.52 (210.80) | 14.39 (207.16) | 14.39 (207.16) | 20.40 (416.38) | 17.44 (314.09) |
| S. Em. ± | 0.03 | 0.03 | 0.03 | 0.22 | 0.04 | 0.14 | 0.22 | 0.31 | 0.27 |
| C.D. at 5 % | 0.09 | 0.09 | 0.08 | 0.63 | 0.11 | 0.39 | 0.61 | 0.87 | 0.75 |
| C.V. % | 5.04 | 5.2 | 4.2 | 12.7 | 2.16 | 7.8 | 11.5 | 12.04 | 11.9 |
| Interaction | NS | NS | NS | NS | NS | NS | NS | NS | NS |

( $\sqrt{X}$ transformed values)
* Figures in parentheses are original value

### 4.5.2.3.3 Interaction effect of I x W on weed counts

The interaction of irrigation schedules and weed management practices was non significant during both the years and in pooled analysis.

### 4.5.3 Dry weed weight recorded at various intervals

Total dry weight of weeds recorded at 3 and 6 WAS and at harvest are presented in Table 4.27 during both the years and in pooled data.

**Table 4.27 : Effect of irrigation and weed management practices on weed dry weight at 3 and 6 WAS and at harvest**

| | 3 WAS ($g\ m^{-2}$) | | | 6 WAS ($g\ m^{-2}$) | | | Harvest ($kg\ ha^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled |
| **Irrigation (I)** | | | | | | | | | |
| $I_1$ | 43.70 | 45.00 | 44.35 | 86.81 | 89.20 | 88.00 | 3838.68 | 3891.18 | 3862.43 |
| $I_2$ | 43.89 | 45.45 | 44.64 | 89.36 | 91.97 | 90.67 | 3823.78 | 3880.07 | 3851.93 |
| $I_3$ | 42.95 | 44.51 | 43.73 | 84.96 | 87.87 | 86.41 | 3811.07 | 3869.89 | 3840.48 |
| $I_4$ | 42.12 | 43.50 | 42.81 | 86.57 | 90.38 | 88.45 | 3805.68 | 3863.64 | 3834.66 |
| S. Em. ± | 0.37 | 0.39 | 0.27 | 0.80 | 0.71 | 0.53 | 4.99 | 4.67 | 3.40 |
| C.D. at 5 % | 1.17 | 1.24 | 0.79 | 2.57 | 2.26 | 1.59 | 15.96 | 14.95 | 10.10 |
| C.V. % | 4.49 | 4.60 | 4.54 | 4.88 | 4.17 | 4.53 | 6.90 | 6.38 | 6.61 |
| **Weed management (W)** | | | | | | | | | |
| $W_1$ | 11.23 | 11.58 | 11.40 | 16.14 | 16.88 | 16.51 | 889.95 | 950.94 | 920.44 |
| $W_2$ | 14.20 | 14.64 | 14.42 | 34.90 | 37.44 | 36.37 | 2006.37 | 2062.12 | 2034.25 |
| $W_3$ | 35.38 | 41.94 | 38.66 | 140.39 | 146.54 | 143.46 | 7447.94 | 7506.44 | 7477.19 |
| $W_4$ | 20.44 | 16.75 | 18.59 | 71.87 | 76.06 | 73.97 | 4010.56 | 4069.37 | 4039.97 |
| $W_5$ | 0.00 | 0.00 | 0.00 | 13.00 | 13.00 | 13.00 | 1664.06 | 1720.69 | 1692.37 |
| $W_6$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 608.18 | 665.87 | 637.03 |
| $W_7$ | 220.83 | 227.39 | 224.11 | 332.19 | 338.60 | 335.39 | 10102.81 | 10157.94 | 10130.38 |
| S. Em. ± | 0.65 | 0.58 | 1.88 | 0.84 | 0.78 | 1.38 | 8.47 | 7.92 | 5.82 |
| C.D. at 5 % | 1.84 | 1.63 | 6.52 | 2.38 | 2.12 | 4.78 | 23.91 | 22.36 | 16.22 |
| C.V.% | 6.06 | 5.17 | 5.62 | 3.88 | 3.49 | 5.91 | 8.8 | 8.17 | 8.55 |
| **Interaction** | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | NS | NS | NS |

**Table 4.28 : Interaction effect of irrigation (I) and weed management practices (W) on total dry weed weight at 3 WAS**

| Irrigation (I) | Weed management practices (W) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ | $W_6$ | $W_7$ |
| **2002-03** | | | | | | | |
| $I_1$ | 9.73 | 12.73 | 37.00 | 21.50 | 0.00 | 0.00 | 224.93 |
| $I_2$ | 11.03 | 14.10 | 35.00 | 20.25 | 0.00 | 0.00 | 226.47 |
| $I_3$ | 11.58 | 14.94 | 34.50 | 20.00 | 0.00 | 0.00 | 219.62 |
| $I_4$ | 12.56 | 15.03 | 35.00 | 20.00 | 0.00 | 0.00 | 212.28 |
| S. Em. $\pm$ | 1.30 | | | | | | |
| C. D. at 5 % | 3.69 | | | | | | |
| C. V. % | 6.06 | | | | | | |
| **2003-04** | | | | | | | |
| $I_1$ | 10.25 | 13.35 | 42.50 | 16.25 | 0.00 | 0.00 | 232.63 |
| $I_2$ | 11.47 | 14.67 | 41.75 | 16.75 | 0.00 | 0.00 | 233.47 |
| $I_3$ | 11.88 | 15.29 | 42.00 | 16.50 | 0.00 | 0.00 | 225.90 |
| $I_4$ | 12.71 | 15.24 | 41.50 | 17.50 | 0.00 | 0.00 | 217.5 |
| S. Em. $\pm$ | 1.53 | | | | | | |
| C. D. at 5 % | 3.25 | | | | | | |
| C. V. % | 5.16 | | | | | | |
| **Pooled** | | | | | | | |
| $I_1$ | 9.99 | 13.04 | 39.75 | 18.87 | 0.00 | 0.00 | 228.78 |
| $I_2$ | 11.25 | 14.38 | 38.37 | 18.50 | 0.00 | 0.00 | 229.97 |
| $I_3$ | 11.73 | 15.11 | 38.25 | 18.25 | 0.00 | 0.00 | 222.76 |
| $I_4$ | 12.63 | 15.13 | 38.25 | 18.75 | 0.00 | 0.00 | 214.91 |
| S. Em. $\pm$ | 0.87 | | | | | | |
| C. D. at 5 % | 2.43 | | | | | | |
| C. V. % | 5.61 | | | | | | |

**Table 4.29 : Interaction effect of irrigation (I) and weed management practices (W) on total dry weed weight at 6 WAS**

| Irrigation (I) | Weed management practices (W) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ | $W_6$ | $W_7$ |
| **2002-03** | | | | | | | |
| $I_1$ | 15.16 | 33.95 | 141.30 | 70.00 | 13.00 | 0.00 | 334.24 |
| $I_2$ | 16.55 | 33.82 | 147.12 | 72.50 | 13.00 | 0.00 | 342.58 |
| $I_3$ | 16.45 | 37.62 | 135.66 | 72.75 | 14.25 | 0.00 | 317.99 |
| $I_4$ | 16.40 | 34.20 | 137.48 | 72.25 | 11.75 | 0.00 | 333.95 |
| S. Em. ± | 1.69 | | | | | | |
| C. D. at 5 % | 4.77 | | | | | | |
| C. V. % | 3.88 | | | | | | |
| **2003-04** | | | | | | | |
| $I_1$ | 16.18 | 36.21 | 145.06 | 76.50 | 12.25 | 0.00 | 338.25 |
| $I_2$ | 17.06 | 37.07 | 151.37 | 76.00 | 12.75 | 0.00 | 349.54 |
| $I_3$ | 17.37 | 40.63 | 143.96 | 75.75 | 14.75 | 0.00 | 332.61 |
| $I_4$ | 16.90 | 37.45 | 145.75 | 76.00 | 12.25 | 0.00 | 343.99 |
| S. Em. ± | 1.57 | | | | | | |
| C. D. at 5 % | 4.24 | | | | | | |
| C. V. % | 3.49 | | | | | | |
| **Pooled** | | | | | | | |
| $I_1$ | 15.67 | 38.08 | 143.18 | 73.25 | 12.62 | 0.00 | 336.24 |
| $I_2$ | 16.80 | 35.44 | 149.24 | 74.25 | 12.87 | 0.00 | 346.05 |
| $I_3$ | 16.92 | 39.12 | 139.81 | 74.25 | 14.50 | 0.00 | 320.30 |
| $I_4$ | 16.65 | 35.82 | 141.68 | 74.12 | 12.00 | 0.00 | 338.96 |
| S. Em. ± | 1.15 | | | | | | |
| C. D. at 5 % | 3.21 | | | | | | |
| C. V. % | 3.68 | | | | | | |

#### 4.5.3.1 Effect of irrigation on dry weed weight

Dry weight of weeds recorded at 3 and 6 WAS and at harvest was significantly influenced by various levels of irrigation during both the years and in pooled analysis. Among different irrigation treatments, $I_4$ (irrigation at 0.40 IW : CPE ) showed significantly lower dry weed weight which was at par with treatment $I_3$ recorded at 3 WAS and at harvest during 2002-03 and 2003-04 and in pooled analysis. At 6 WAS, trend was not noticed.

#### 4.5.3.2 Effect of weed management practices on dry weed weight

Data presented in Table 4.27 indicated significant influence in dry weed weight recorded at various intervals during both the years and in pooled analysis. Treatment $W_6$ (HW at 3 and 6 WAS) secured significantly lowest dry weed weight recorded at 6 WAS and at harvest. While at 3 WAS, it was at par with treatment $W_5$ (HW weeding at 3 WAS and earthing up at 6 WAS). Among herbicidal treatments, significantly lowest dry weed weight was recorded in $W_1$ (fluchloralin 1.0 kg $ha^{-1}$ as PE) during individual years and in pooled data at 3 and 6 WAS as well as at harvest.

#### 4.5.3.3 Interaction effect of I x W on dry weed weight

The interaction effect of irrigation schedules and weed management practices were observed at 3 and 6 WAS during individual years and in pooled analysis, while it was not significant at harvest.

Interactive effect of irrigation schedules and weed management practices on dry weed weight recorded at 3 WAS is presented in Table 4.28. Results indicated that significantly lower dry weed weight was recorded in $I_4W_6$ treatment which was at par with $I_4W_5$, $I_3W_6$, $I_3W_5$, $I_2W_6$, $I_2W_5$, $I_1W_6$ and $I_1W_5$ during individual years and also in pooled analysis.

Interactive effect of irrigation schedules and weed management practices was also found significant on dry weed weight recorded at 6 WAS (Table 4.29). Significantly lower dry weed weight was recorded in $I_4W_6$ treatment combination which was at par with $I_3W_6$, $I_2W_6$, and $I_1W_6$ during 2002-03, 2003-04 and in pooled data. The maximum dry weed weight was recorded in $I_2W_7$ combination which was statistically superior to rest of the combinations of irrigation and weed management practices during individual years and also in pooled analysis.

**4.5.4 Weed Control Efficiency (%)**

The weed control efficiency calculated in terms of percentage at 3 and 6 WAS and at harvest has been presented in Table 4.30.

A perusal of data showed that treatment $W_6$ recorded the highest weed control efficiency at all the stages. Weed control efficiency varies between 82.74 to 100.00, 57.94 to 100.00 and 26.18 to 93.91 at 3 and 6 WAS and at harvest, respectively in pooled analysis.

**Table 4.30 : Weed control efficiency (%) as influenced by different weed management practices at various intervals**

| Weed management practices (W) | 2002-03 | 2003-04 | Pooled |
|---|---|---|---|
| | | **3 WAS** | |
| $W_1$ : Fluchloralin 1.0 kg ha$^{-1}$ (PE) | 94.91 | 94.90 | 94.91 |
| $W_2$ : Pendimethalin 1.0 kg ha$^{-1}$ (PE) | 93.56 | 93.57 | 93.57 |
| $W_3$ : Metolachlor 1.0 kg ha$^{-1}$ (PE) | 83.97 | 81.56 | 82.74 |
| $W_4$ : Oxadiargyl 100 g ha$^{-1}$ (PE) | 90.74 | 92.64 | 91.70 |
| $W_5$ : One HW at 3 WAS and earthing up at 6 WAS | 100.00 | 100.00 | 100.00 |
| $W_6$ : Weed free (HW at 3 and 6 WAS) | 100.00 | 100.00 | 100.00 |
| $W_7$ : Weedy check | -- | -- | -- |
| | | **6 WAS** | |
| $W_1$ : Fluchloralin 1.0 kg ha$^{-1}$ (PE) | 95.14 | 95.01 | 95.08 |
| $W_2$ : Pendimethalin 1.0 kg ha$^{-1}$ (PE) | 89.50 | 88.94 | 89.16 |
| $W_3$ : Metolachlor 1.0 kg ha$^{-1}$ (PE) | 57.73 | 56.72 | 57.22 |
| $W_4$ : Oxadiargyl 100 g ha$^{-1}$ (PE) | 73.86 | 77.53 | 77.94 |
| $W_5$ : One HW at 3 WAS and earthing up at 6 WAS | 96.08 | 96.16 | 96.12 |
| $W_6$ : Weed free (HW at 3 and 6 WAS) | 100.00 | 100.00 | 100.00 |
| $W_7$ : Weedy check | -- | -- | -- |
| | | **At harvest** | |
| $W_1$ : Fluchloralin 1.0 kg ha$^{-1}$ (PE) | 91.12 | 90.63 | 90.91 |
| $W_2$ : Pendimethalin 1.0 kg ha$^{-1}$ (PE) | 80.14 | 79.69 | 79.91 |
| $W_3$ : Metolachlor 1.0 kg ha$^{-1}$ (PE) | 26.27 | 26.10 | 26.18 |
| $W_4$ : Oxadiargyl 100 g ha$^{-1}$ (PE) | 60.30 | 59.93 | 60.12 |
| $W_5$ : One HW at 3 WAS and earthing up at 6 WAS | 83.52 | 83.06 | 83.29 |
| $W_6$ : Weed free (HW at 3 and 6 WAS) | 93.98 | 93.44 | 93.71 |
| $W_7$ : Weedy check | -- | -- | -- |

### 4.5.5 Weed Index (%)

Weed index calculated in terms of percentage at harvest is presented in Table 4.31. It is evident from the data that lowest weed index (0.0 %) was recorded under the treatment $W_6$ (weed free) followed by $W_1$ (fluchloralin 1.0 kg $ha^{-1}$ as PE), $W_5$ (HW at 3 WAS and earthing up at 6 WAS) and $W_2$ (pendimethalin 1.0 kg $ha^{-1}$ as PE). The highest weed index was observed under treatment $W_7$ (weedy check) during both the years and in pooled analysis.

**Table 4.31: Weed index (%) as influenced by weed management practices**

| Weed management practices (W) | Weed index (%) | | |
|---|---|---|---|
| | 2002-03 | 2003-04 | Pooled |
| $W_1$ : Fluchloralin 1.0 kg $ha^{-1}$ (PE) | 16.33 | 18.76 | 17.51 |
| $W_2$ : Pendimethalin 1.0 kg $ha^{-1}$ (PE) | 24.02 | 25.80 | 24.89 |
| $W_3$ : Metolachlor 1.0 kg $ha^{-1}$ (PE) | 58.39 | 59.33 | 58.85 |
| $W_4$ : Oxadiargyl 100 g $ha^{-1}$ (PE) | 78.10 | 78.86 | 78.47 |
| $W_5$ : One HW at 3 WAS and earthing up at 6 WAS | 18.37 | 20.39 | 19.35 |
| $W_6$ : Weed free (HW at 3 and 6 WAS) | 0.00 | 0.00 | 0.00 |
| $W_7$ : Weedy check | 94.05 | 94.55 | 94.29 |

### 4.5.6 Nutrient uptake by weeds (kg $ha^{-1}$) at harvest

The uptake of N, $P_2O_5$ and $K_2O$ by weeds was present in Table 4.32.

#### 4.5.6.1 Effect of irrigation on nutrient uptake by weeds

Perusal of data presented in Table 4.32 showed that N uptake by weeds during the year 2002-03 and 2003-04 of study as well as in pooled analysis was significantly influenced by irrigation schedules, while $P_2O_5$ and $K_2O$ uptake was not significantly influenced due to irrigation schedules at harvest.

Significantly the highest N uptake by weeds was recorded in $I_2$ treatment which was 14.93 kg $ha^{-1}$, 15.14 kg $ha^{-1}$ and 15.04 kg $ha^{-1}$ during the year 2002-03 and 2003-04 and in pooled, respectively. The lowest N uptake was observed in $I_4$ irrigation schedules.

#### 4.5.6.2 Effect of weed management practices on nutrient uptake by weeds

It is observed from the data presented in Table 4.32 that nutrients uptake by weeds was significant due to weed management practices. Treatment $W_6$ (HW at 3 and 6 WAS) noticed significantly the lower nutrients uptake *viz.,* N, $P_2O_5$ and $K_2O$ than treatment $W_1$ (fluchloralin 1.0 kg $ha^{-1}$ as PE) during individual years of study and in pooled analysis. Maximum (N, $P_2O_5$ and $K_2O$) nutrients were drained by treatment $W_7$ (weedy check) which was significantly the highest during both the years and also in pooled analysis.

**Table 4.32 : Effect of irrigation and weed management practices on N, $P_2O_5$ and $K_2O$ uptake (kg ha$^{-1}$) by weeds at harvest**

| Treatments | Nitrogen (N) | | | Phosphorus ($P_2O_5$) | | | Potash ($K_2O$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled | 2002-03 | 2003-04 | Pooled |
| **Irrigation (I)** | | | | | | | | | |
| $I_1$ | 12.67 | 12.67 | 12.67 | 5.85 | 5.93 | 5.89 | 26.39 | 26.79 | 26.59 |
| $I_2$ | 14.93 | 15.14 | 15.04 | 5.78 | 5.87 | 5.83 | 26.13 | 26.48 | 26.31 |
| $I_3$ | 11.28 | 11.45 | 11.39 | 5.55 | 5.63 | 5.59 | 29.54 | 26.45 | 26.49 |
| $I_4$ | 10.23 | 10.38 | 10.31 | 5.98 | 6.07 | 6.03 | 25.97 | 26.36 | 25.17 |
| S. Em. ± | 0.32 | 0.28 | 0.32 | 0.18 | 0.18 | 0.18 | 0.21 | 1.13 | 0.19 |
| C.D. at 5 % | 1.03 | 0.91 | 1.00 | NS | NS | NS | NS | NS | NS |
| C.V. % | 13.93 | 12.09 | 13.52 | 16.31 | 16.14 | 16.22 | 14.30 | 23.97 | 13.15 |
| **Weed management (W)** | | | | | | | | | |
| $W_1$ | 2.63 | 2.80 | 2.71 | 1.53 | 1.62 | 1.58 | 6.10 | 6.49 | 6.30 |
| $W_2$ | 6.89 | 7.07 | 6.98 | 3.30 | 3.40 | 3.35 | 13.53 | 13.90 | 13.72 |
| $W_3$ | 21.39 | 21.55 | 21.47 | 11.10 | 11.18 | 11.14 | 48.99 | 49.38 | 49.19 |
| $W_4$ | 13.76 | 1382 | 1379 | 6.26 | 6.35 | 6.31 | 28.03 | 28.44 | 28.24 |
| $W_5$ | 5.72 | 5.91 | 5.82 | 2.15 | 2.22 | 2.19 | 11.32 | 11.67 | 11.18 |
| $W_6$ | 1.45 | 1.59 | 1.52 | 0.83 | 0.91 | 0.87 | 4.03 | 4.41 | 4.22 |
| $W_7$ | 34.12 | 34.13 | 34.13 | 15.37 | 15.46 | 15.42 | 70.98 | 67.60 | 69.29 |
| S. Em. ± | 0.81 | 0.82 | 0.81 | 0.18 | 0.18 | 0.24 | 0.47 | 1.51 | 0.86 |
| C.D. at 5 % | 2.28 | 2.32 | 2.29 | 0.50 | 0.51 | 0.78 | 1.34 | 4.25 | 2.42 |
| C.V. % | 26.25 | 26.49 | 26.30 | 12.27 | 12.28 | 12.27 | 17.24 | 23.26 | 13.60 |
| **Interaction** | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | NS | Sig. |

### 4.5.6.3 Interaction effect of I x W on nutrient uptake by weeds

**Nitrogen (N) uptake**

Removal of nitrogen by weeds due to combination of irrigation schedules and weed management practices are presented in Table 4.33. Results revealed that significantly lower nitrogen uptake was recorded in combination of $I_1W_6$ during 2002-03 (1.20 kg ha $^{-1}$), 2003-04 (1.31 kg ha$^{-1}$) and in pooled data (1.26 kg ha$^{-1}$) which was statistically at par with $I_2W_6$, $I_3W_6$, $I_4W_6$, $I_1W_5$, $I_3W_5$, $I_4W_5$, $I_1W_1$, $I_2W_1$, $I_3W_1$, $I_4W_1$, $I_3W_2$ and $I_4W_2$.

**Phosphorus ($P_2O_5$) Uptake**

Interactive effect of irrigation schedules and weed management practices on $P_2O_5$ uptake by weeds was presented in Table 4.34. Significantly lower $P_2O_5$ removal by weeds was recorded in $I_4W_6$ combination which was not differ to $I_3W_6$, $I_2W_6$, $I_1W_6$, $I_1W_1$, $I_2W_1$, $I_3W_1$ and $I_4W_1$ during individual years as well as in pooled data.

**Potash ($K_2O$) Uptake**

In the case of $K_2O$ uptake by weeds due to interactive effect of irrigation schedules and weed management practices, it was significant during the year 2002-03 and in pooled data (Table 4.35). Results revealed that combination of $I_2W_6$ secured significantly lower $K_2O$ uptake (3.61 kg ha$^{-1}$) during 2002-03 which was at par with $I_3W_6$, $I_4W_6$, $I_1W_6$, and $I_2W_1$ while in pooled analysis (3.77 kg ha$^{-1}$) it was at par with $I_1W_6$, $I_3W_6$, $I_4W_6$, $I_1W_1$, $I_2W_1$, $I_3W_1$ and $I_4W_2$.

**Table 4.33 : Interaction effect of irrigation (I) and weed management practices (W) on N uptake (kg $ha^{-1}$) by weeds**

| Irrigation (I) | Weed management practices (W) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ | $W_6$ | $W_7$ |
| **2002-03** | | | | | | | |
| $I_1$ | 2.76 | 6.80 | 25.14 | 15.74 | 5.15 | 1.20 | 31.93 |
| $I_2$ | 1.74 | 8.99 | 29.22 | 16.85 | 6.25 | 1.57 | 39.64 |
| $I_3$ | 3.51 | 2.36 | 18.72 | 10.09 | 5.6 | 1.53 | 33.91 |
| $I_4$ | 2.52 | 2.48 | 12.48 | 12.36 | 5.6 | 1.50 | 30.99 |
| S. Em. ± | 1.61 | | | | | | |
| C.D. at 5 % | 4.55 | | | | | | |
| C. V. % | 26.25 | | | | | | |
| **2003-04** | | | | | | | |
| $I_1$ | 2.95 | 6.94 | 25.35 | 15.40 | 5.32 | 1.31 | 31.41 |
| $I_2$ | 1.87 | 9.24 | 29.44 | 17.11 | 6.73 | 1.72 | 39.86 |
| $I_3$ | 3.73 | 5.75 | 18.84 | 10.25 | 5.78 | 1.68 | 34.09 |
| $I_4$ | 2.64 | 6.35 | 12.56 | 12.51 | 5.79 | 1.64 | 31.17 |
| S. Em. ± | 1.64 | | | | | | |
| C.D. at 5 % | 4.64 | | | | | | |
| C. V. % | 26.49 | | | | | | |
| **Pooled** | | | | | | | |
| $I_1$ | 2.86 | 6.87 | 25.25 | 15.59 | 5.24 | 1.26 | 31.67 |
| $I_2$ | 1.81 | 9.12 | 29.33 | 16.95 | 6.63 | 1.65 | 39.75 |
| $I_3$ | 3.62 | 5.76 | 18.78 | 10.17 | 5.69 | 1.60 | 34.0 |
| $I_4$ | 2.58 | 6.26 | 12.52 | 12.44 | 5.70 | 1.57 | 31.08 |
| S. Em. ± | 1.62 | | | | | | |
| C.D. at 5 % | 4.58 | | | | | | |
| C. V. % | 26.30 | | | | | | |

**Table 4.34 : Interaction effect of irrigation (I) and weed management practices (W) on $P_2O_5$ uptake (kg $ha^{-1}$) by weeds**

| Irrigation (I) | Weed management practices (W) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ | $W_6$ | $W_7$ |
| **2002-03** | | | | | | | |
| $I_1$ | 1.70 | 3.35 | 10.63 | 6.36 | 2.08 | 0.81 | 15.99 |
| $I_2$ | 1.51 | 3.28 | 10.68 | 5.55 | 1.94 | 0.94 | 16.56 |
| $I_3$ | 1.31 | 2.91 | 10.43 | 6.19 | 2.05 | 0.83 | 15.13 |
| $I_4$ | 1.85 | 3.64 | 12.65 | 6.93 | 2.52 | 0.75 | 13.79 |
| S. Em. ± | 0.36 | | | | | | |
| C. D. at 5 % | 1.0 | | | | | | |
| C. V. % | 12.27 | | | | | | |
| **2003-04** | | | | | | | |
| $I_1$ | 1.81 | 3.44 | 10.71 | 6.45 | 2.14 | 0.89 | 16.1 |
| $I_2$ | 1.61 | 3.38 | 10.76 | 5.63 | 2.01 | 1.02 | 16.65 |
| $I_3$ | 1.39 | 3.00 | 10.51 | 6.28 | 2.12 | 0.91 | 15.22 |
| $I_4$ | 1.68 | 3.76 | 12.74 | 7.03 | 2.62 | 0.83 | 13.86 |
| S. Em. ± | 0.36 | | | | | | |
| C. D. at 5 % | 1.02 | | | | | | |
| C. V. % | 12.28 | | | | | | |
| **Pooled** | | | | | | | |
| $I_1$ | 1.76 | 3.39 | 10.67 | 6.41 | 2.11 | 0.85 | 16.05 |
| $I_2$ | 1.56 | 3.33 | 10.72 | 5.59 | 1.97 | 0.98 | 16.61 |
| $I_3$ | 1.35 | 2.96 | 10.47 | 6.24 | 2.09 | 0.87 | 15.18 |
| $I_4$ | 1.63 | 3.70 | .12.70 | 6.98 | 2.57 | 0.79 | 13.63 |
| S. Em. ± | 0.76 | | | | | | |
| C. D. at 5 % | 1.01 | | | | | | |
| C. V. % | 12.27 | | | | | | |

**Table 4.35 : Interaction effect of irrigation (I) and weed management practices (W) on $K_2O$ uptake (kg $ha^{-1}$) by weeds**

| Irrigation (I) | Weed management practices (W) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ | $W_6$ | $W_7$ |
| **2002-03** | | | | | | | |
| $I_1$ | 7.24 | 14.89 | 47.74 | 31.20 | 11.94 | 4.15 | 67.55 |
| $I_2$ | 5.40 | 13.29 | 49.20 | 26.84 | 11.59 | 3.61 | 73.01 |
| $I_3$ | 5.75 | 12.34 | 55.58 | 24.29 | 11.22 | 4.14 | 69.18 |
| $I_4$ | 6.01 | 13.61 | 43.47 | 29.77 | 10.53 | 4.23 | 74.19 |
| S. Em. ± | 0.95 | | | | | | |
| C. D. at 5 % | 2.67 | | | | | | |
| C. V. % | 7.24 | | | | | | |
| **Pooled** | | | | | | | |
| $I_1$ | 7.46 | 15.08 | 47.93 | 31.43 | 12.13 | 4.35 | 67.77 |
| $I_2$ | 5.56 | 13.47 | 49.39 | 27.04 | 11.77 | 3.77 | 37.14 |
| $I_3$ | 5.93 | 12.51 | 55.74 | 24.46 | 11.80 | 4.33 | 69.38 |
| $I_4$ | 6.2 | 13.81 | 43.630 | 2.99 | 10.70 | 4.44 | 74.39 |
| S. Em. ± | 1.71 | | | | | | |
| C. D. at 5 % | 4.83 | | | | | | |
| C. V. % | 13.16 | | | | | | |

## 4.6 ECONOMICS

The data on economics of dill seed crop as influenced by different irrigation schedules and weed management practices are furnished in Tables 4.36 and 4.37. The gross as well as net realization and cost of production per hectare for individual treatment and treatment combination were worked out on the basis of mean grain yield and considering the prevailing market prices.

**Table 4.36 :Economics for different treatments (Average of two years)**

| Treatment Combina-tions | Seed Yield ($kg\ ha^{-1}$) | | Gross realization ($Rs\ ha^{-1}$) | Cost of cultivation ($Rs\ ha^{-1}$) | Net realization ($Rs\ ha^{-1}$) | CBR |
|---|---|---|---|---|---|---|
| | 2002-03 | 2003-04 | | | | |
| **Irrigation (I)** | | | | | | |
| $I_1$ | 1040 | 968 | 13613 | 9730 | 3882 | 1 : 1.27 |
| $I_2$ | 1123 | 1033 | 14625 | 10219 | 4406 | 1 : 1.33 |
| $I_3$ | 1326 | 1226 | 17307 | 10974 | 6332 | 1 : 1.48 |
| $I_4$ | 1508 | 1410 | 19774 | 11695 | 8078 | 1 : 1.57 |
| **Weed management practices (W)** | | | | | | |
| $W_1$ | 1781 | 1639 | 23200 | 11964 | 11235 | 1 : 1.94 |
| $W_2$ | 1618 | 1497 | 21118 | 11623 | 9495 | 1 : 1.78 |
| $W_3$ | 886 | 820 | 11568 | 10100 | 1467 | 1 : 1.13 |
| $W_4$ | 466 | 426 | 6057 | 8794 | -2737 | 1 : 0.67 |
| $W_5$ | 1738 | 1606 | 22677 | 11586 | 11090 | 1 : 1.95 |
| $W_6$ | 2129 | 2017 | 28079 | 12608 | 15471 | 1 : 2.21 |
| $W_7$ | 126 | 109 | 1610.23 | 7907.10 | -6296 | 1 : 0.20 |

**Price:** 15.00 Rs. $kg^{-1}$ for dill seed during 2002-03
12.00 Rs. $kg^{-1}$ for dill seed during 2003-04

**Table 4.37 : Economics for different treatment combinations (Average of two years)**

| Treatment No. | Treatment Combinations | Seed yield (kg ha$^{-1}$) | | Gross realization (Rs ha$^{-1}$) | Cost of cultivation (Rs ha$^{-1}$) | Net realization (Rs ha$^{-1}$) | CBR |
|---|---|---|---|---|---|---|---|
| | | 2002-03 | 2003-04 | | | | |
| $T_1$ | $I_1W_1$ | 1600 | 1475 | 20844 | 11098 | 9746 | 1 : 1.88 |
| $T_2$ | $I_1W_2$ | 949 | 863 | 12299 | 9722 | 2576 | 1 : 1.27 |
| $T_3$ | $I_1W_3$ | 708 | 653 | 9229 | 9237 | -8 | 1 : 1.00 |
| $T_4$ | $I_1W_4$ | 248 | 229 | 3233 | 7853 | -4620 | 1 : 0.41 |
| $T_5$ | $I_1W_5$ | 1477 | 1359 | 19229 | 10545 | 8684 | 1 : 1.82 |
| $T_6$ | $I_1W_6$ | 2215 | 2130 | 29392 | 12329 | 17063 | 1 : 2.24 |
| $T_7$ | $I_1W_7$ | 83 | 74 | 1069 | 7331 | -6261 | 1 : 0.15 |
| $T_8$ | $I_2W_1$ | 1748 | 1597 | 22691 | 11720 | 10971 | 1 : 1.94 |
| $T_9$ | $I_2W_2$ | 1657 | 1530 | 21611 | 11539 | 10072 | 1 : 1.87 |
| $T_{10}$ | $I_2W_3$ | 688 | 639 | 8990 | 9525 | -535 | 1 : 0.94 |
| $T_{11}$ | $I_2W_4$ | 324 | 296 | 4208 | 8336 | -4127 | 1 : 0.50 |
| $T_{12}$ | $I_2W_5$ | 1764 | 1618 | 22938 | 11465 | 11472 | 1 : 2.00 |
| $T_{13}$ | $I_2W_6$ | 1553 | 1442 | 20302 | 11201 | 9101 | 1 : 1.81 |
| $T_{14}$ | $I_2W_7$ | 130 | 111 | 1639 | 7748 | -6110 | 1 : 0.21 |
| $T_{15}$ | $I_3W_1$ | 1766 | 1634 | 23052 | 12104 | 10948 | 1 : 1.90 |
| $T_{16}$ | $I_3W_2$ | 1595 | 1479 | 20837 | 11741 | 9096 | 1 : 1.77 |
| $T_{17}$ | $I_3W_3$ | 1120 | 1051 | 14708 | 10767 | 3942 | 1 : 1.37 |
| $T_{18}$ | $I_3W_4$ | 611 | 556 | 7917 | 9255 | -1339 | 1 : 0.86 |
| $T_{19}$ | $I_3W_5$ | 1720 | 1586 | 22413 | 11708 | 10705 | 1 : 1.91 |
| $T_{20}$ | $I_3W_6$ | 2333 | 2164 | 30486 | 13157 | 17329 | 1 : 2.32 |
| $T_{21}$ | $I_3W_7$ | 139 | 116 | 1736 | 8090 | -6354 | 1 : 0.21 |
| $T_{22}$ | $I_4W_1$ | 2014 | 1852 | 26215 | 12937 | 13278 | 1 : 2.03 |
| $T_{23}$ | $I_4W_2$ | 1971 | 1816 | 25675 | 13490 | 12185 | 1 : 1.90 |
| $T_{24}$ | $I_4W_3$ | 1028 | 940 | 13347 | 10875 | 2472 | 1 : 1.23 |
| $T_{25}$ | $I_4W_4$ | 683 | 625 | 8872 | 9735 | -863 | 1 : 0.91 |
| $T_{26}$ | $I_4W_5$ | 1993 | 1863 | 26129 | 12629 | 13500 | 1 : 2.07 |
| $T_{27}$ | $I_4W_6$ | 2417 | 2336 | 32139 | 13748 | 18391 | 1 : 2.34 |
| $T_{28}$ | $I_4W_7$ | 155 | 139 | 1997 | 8459 | -6462 | 1 : 0.24 |

**Price:** 15.00 Rs. kg$^{-1}$ for dill seed during 2002-03
12.00 Rs. kg$^{-1}$ for dill seed during 2003-04

### 4.6.1 Effect of irrigation on economics

The data presented in table 4.36 revealed that the highest net return of Rs. 8078 ha$^{-1}$ was occurred with the scheduling irrigation at 0.40

IW : CPE ($I_4$) followed by scheduling irrigation at 3 critical crop growth stage ($I_3$) with net returns of Rs. 6332 $ha^{-1}$. The lowest net return of Rs. 3882 $ha^{-1}$ was realized under scheduling the irrigation at only vegetative crop growth stage ($I_1$).

### 4.6.2 Effect of weed management practices on economics

The data reported in Table 4.36 revealed that the highest net profit of Rs. 15471 $ha^{-1}$ was realized under treatment $W_6$ (HW at 3 and 6 WAS), followed by $W_5$ (HW at 3 WAS and earthing up at 6 WAS) and $W_1$ (fluchloralin 1.0 kg $ha^{-1}$ as PE). The highest loss was occurred Rs. 6297 $ha^{-1}$ under weedy check ($W_7$) followed by $W_4$ (oxadiargyl 100 g $ha^{-1}$ as PE).

### 4.6.3 Treatment combinations

The economics for combinations of irrigation schedules and weed management practices was also workout on the basis of pooled analysis. The data presented in Table 4.37 indicated that the highest net realization of Rs. 18391 $ha^{-1}$ was realized under treatment combination $I_4W_6$ (irrigation at 0.40 IW : CPE along with twice HW at 3 and 6 WAS) followed by $I_3W_6$ (Rs. 17329 $ha^{-1}$) and $I_4W_6$ (Rs. 13500 $ha^{-1}$). The highest loss of Rs. 6462 was noticed with treatment combination $I_4W_7$(irrigation at 0.40 IW : CPE under weedy check).

#### 4.6.4 Cost Benefit Ratio (CBR)

The cost benefit ratio as influenced by irrigation schedules and weed management practices was also calculated and presented in Table 4.36 and 4.37.

##### 4.6.4.1 Effect of irrigation on CBR

The data presented in Table 4.36 showed that the highest CBR value 1:1.57 was recorded under 0.40 IW : CPE ($I_4$), while the lowest value of CBR (1 : 1.27) was recorded with $I_1$ (irrigation at vegetative growth stage ).

##### 4.6.4.2 Effect of weed management practices on CBR

The data in Table 4.36 further revealed that the highest CBR 1 : 2.21 was recorded under $W_6$ (HW at 3 and 6 WAS), where as the lowest CBR of 1 : 0.20 was obtained with weedy check treatment. Treatment $W_5$ (HW at 3 WAS and earthing up at 6 WAS) was the next best treatment in terms of CBR (1 : 1.95).

##### 4.6.4.3 Treatment combinations

The data given in Table 4.37 indicated that the highest CBR of 1 : 2.34 was recorded under treatment combination of $I_4W_6$ (irrigation at 0.40 IW : CPE and twice HW at 3 and 6 WAS) closely followed by $I_3W_6$ (1:2.32) and $I_1W_6$ (1:2.24). The lowest CBR of 1 : 0.21 was recorded under the treatment combination of $I_2W_7$ (irrigation at vegetative growth stage and at 50 % flowering with weedy check) which was differed with $I_2W_7$ (irrigation at critical stage with weedy check).

# Discussion

# V. DISCUSSION

The results of the investigation entitled, "Response of dill seed (*Anethum graveolens* L.) to irrigation and weed management practices under middle Gujarat agro-climatic condition" described in the previous chapter are discussed critically with the probable "effect and causes relationship" and supported with relevant references based on experimental evidences. For the sake of conveniency this chapter has been discussed under the following sub-heads.

5.1 Effect of weather parameters on crop and weeds

5.2 Effect of irrigation schedules on crop and weeds

5.3 Effect of weed management practices on crop and weeds

5.4 Interaction effect of irrigation schedules and weed management practices on crop and weeds

5.5 Economics

## 5.1 EFFECT OF WEATHER PARAMETERS ON CROP AND WEEDS

Among the various factors responsible for affecting the yield and performance of crop as well as associated weeds, the weather condition play a key role. The growth, development and finally the seed yield is the expression of prevalent weather condition, particularly temperature, sunshine hours, humidity and soil moisture availability during the crop seasons. The various weather parameters for the years 2002-03 and 2003-04 for crop seasons are presented in Table 3.1 and graphically illustrated in Fig. 3.1 and 3.2.

It is evident from the meteorological data given in Table 3.1 that all the parameters remain comparatively similar during both the season of crop. During the years of 2002-03 and 2003-04, treatment $I_4$ (IW : CPE 0.40) received total five irrigations with one common irrigation. Remaining irrigation treatments have received 2 ($I_1$), 3 ($I_2$) and 4 ($I_3$) irrigation including one common irrigation at the time of sowing. So, the crop growth was higher under treatment $I_4$ due to higher moisture availability at proper vegetative growth stages.

The weed population was higher during second year (2003-04) than the first year (2002-03). Amongst all the broad leaved weeds, *Chenopodium album* L. was the dominant weed during crop season.

In general, the weather condition during both the years of study were found normal. No major incidence of pests and diseases were found during the crop period. Hence, variations observed in the experiment are attributed to various treatments and treatment combinations applied in the experiment.

## 5.2 EFFECT OF IRRIGATION SCHEDULES ON CROP AND WEEDS

### 5.2.1 Effect on growth characters

In order to obtain maximum possible yield, it is essential for the crop to utilize equality and efficiently all available sources *viz.*, water, nutrients, light and $CO_2$. This could be achieved from a uniform plant population. Plant stand during the initial stage was maintained uniformly by thinning. However, seed germination recorded at 10 DAS and plant stand recorded at harvest (Table 4.1) was not influenced by various irrigation schedules. This indicate that what ever differences observed in growth and yield attributes were mainly due to treatment effect.

The data on periodical plant height (Table 4.2) recorded at various intervals indicated that the irrigation schedules did not influence plant height upto 6 WAS during both the years of the study. However, it commence to increase significantly at 12 and 18 WAS and at harvest. Irrigation treatment $I_4$ (0.40 IW : CPE) recorded significantly higher plant height as compared to rest of the treatments (Fig.5.1). The lowest plant height was recorded under $I_1$ treatment (irrigation applied at vegetative stage) at all crop growth stages. The increase in plant height at harvest under $I_4$ was 10.81 and 11.18 per cent over $I_1$ during 2002-03 and 2003-04, respectively. This might be due to the fact that optimum moisture supply

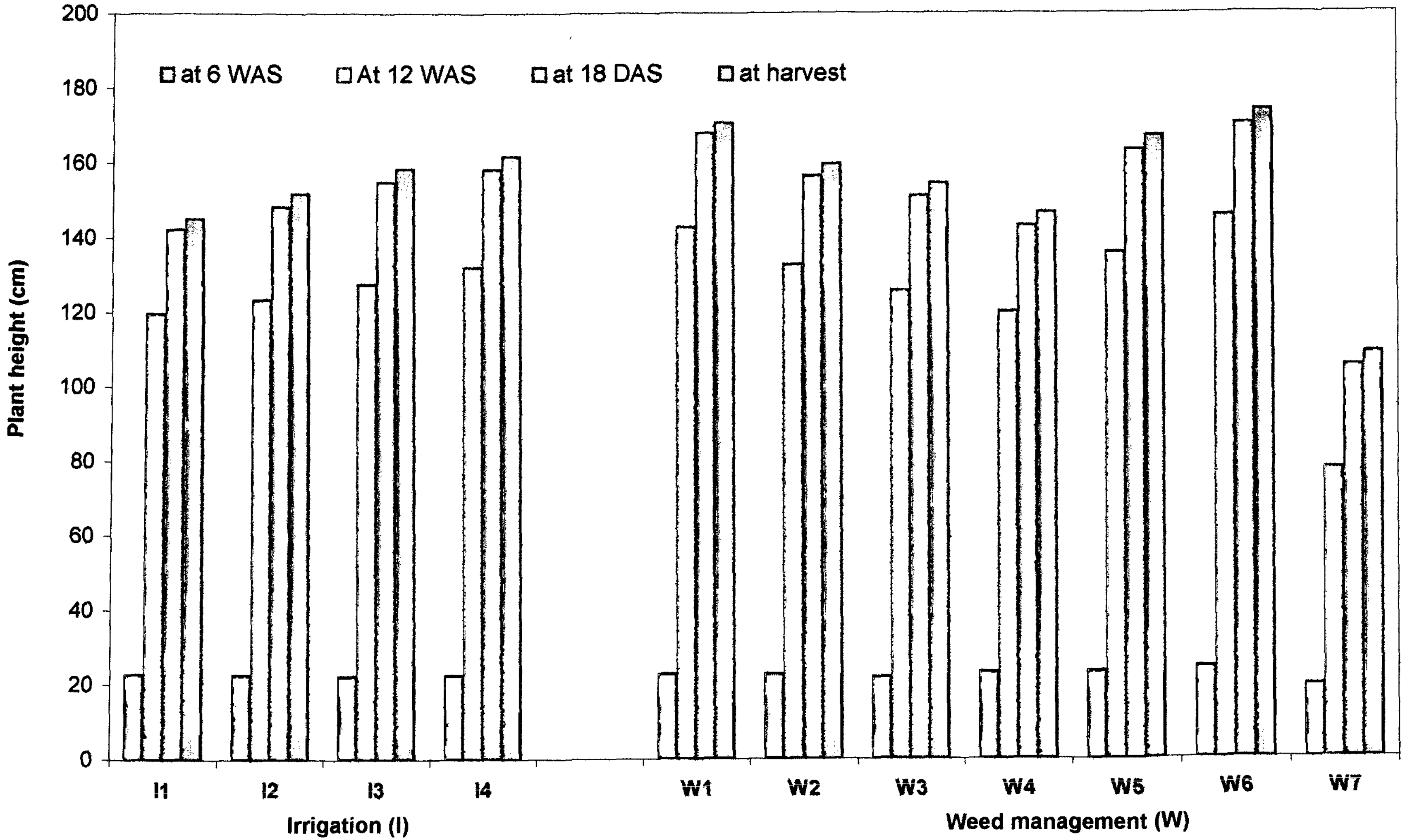



**Fig. 5.1 : Mean plant height (cm) recorded at 6, 12 and 18 WAS and at harvest as influenced by irrigation schedules and weed management practices**

under more frequent irrigation ($I_4$) promoted the division and expansion of all components and thereby stem elongation increased that virtually increased plant growth in terms of plant height. This result was closely accordance with the results reported by Modi (1990). The shorter plant height observed in the treatments of $I_1$which was subjected to water stress at vegetative growth stages. This might be attributed reduced synthesis of growth regulators such as cytokinins and gibberellins (Kramer, 1969).

It is evident from the data presented in Table 4.5 that the number of branches plant$^{-1}$ were increased with increasing in irrigation frequencies from treatment $I_1$ to $I_4$ during both the years of study. Significantly the highest number of branches plant$^{-1}$ were recorded with treatment $I_4$ (0.40 IW : CPE) while lower observed under $I_1$ (one irrigation at vegetative stage). The magnitude of increase in number of branches plant$^{-1}$ in $I_4$ was 28.62 and 29.86 per cent over $I_1$ treatment during 2002-03 and 2003-04, respectively. The optimum moisture supply has promoting effect on most of the physiological processes and plant growth in terms of number of branches plant$^{-1}$. Inadequate moisture supply resulted in lower number of branches plant$^{-1}$ due to deleterious effect on most of the physiological processes of crop. Similar response was also observed by Modi (1990) in dill seed crop.

The results pertaining to days to 50 % flowering (Table 4.7) revealed that the various irrigation levels could not exert a significant influence on the attainment of 50 % flowering stage. Non significant results pertaining to days to 50 % flowering due to irrigation might have been obtained because of same quantity of irrigation applied up to the flowering stage. While, the result pertaining to days to maturity were increased with increasing in irrigation levels from $I_1$ to $I_4$. The higher days to maturity were observed with treatment $I_4$ because of higher frequencies of irrigation leads to more vegetative and reproductive growth, which require more days to maturity.

**5.2.2 Effect on yield attribute characters**

The experimental results in respect to number of umbels plant$^{-1}$, umbellates umbel$^{-1}$ and seeds umbellate$^{-1}$ (Table 4.8) recorded at harvest showed the significant influence due to different irrigation schedules. A marked increased in yield attributes were observed with increasing in irrigation frequencies. The maximum number of umbels plant$^{-1}$ were reported with treatment $I_4$ (0.40 IW : CPE), while minimum under treatment $I_1$ (one irrigation at vegetative stage). The tune of increase under $I_4$ in number of umbels plant$^{-1}$ were 48.99 and 49.96, in number of umbellates umbel$^{-1}$ were 25.42 and 25.73 and in number of seeds umbellate$^{-1}$ were 5.32 and 4.75 per cent over treatment $I_1$ during 2002-03 and 2003-04, respectively. It might be due to adequate moisture supply resulted in increasing number of umbels plant$^{-1}$, number of umbellates umbel$^{-1}$ and number of seeds umbellate$^{-1}$. Similar response was reported and discussed by Modi (1990) in dill seed and Amin (1999) and Joshi (2002) in *Rabi* drilled fennel grown on sandy loam soil.

In the case of 1000 seeds weight (test weight), different irrigation schedules did not affect significantly in individual year but found significant in pooled analysis. In pooled analysis, significantly higher test weight (5.7 per cent) was recorded under treatment $I_4$ over $I_1$. This was due to higher values of yield attributes, reflection of seed size and seed setting achieved well under sufficient moisture supply (5 irrigations) which helped into better translocation of assimilates from source to sink and consequently bolder seed size was obtained, which finally resulted into higher seed yield plant$^{-1}$. This finding is in accordance with finding of Modi (1990) in case of dill seed and Amin (1999) in case of *rabi* drilled fennel.

### 5.2.3 Effect on seed and straw yield and harvest index

Data presented in Table 4.11 revealed that different irrigation schedules influenced the seed and straw yield of dill seed crop during both the year of study and in pooled analysis.

The seed yield of dill seed increased with increasing in irrigation levels (Fig 5.2). The treatment $I_4$ produced significantly the highest seed yield (1459 kg ha$^{-1}$) than rest of the treatments. The lowest

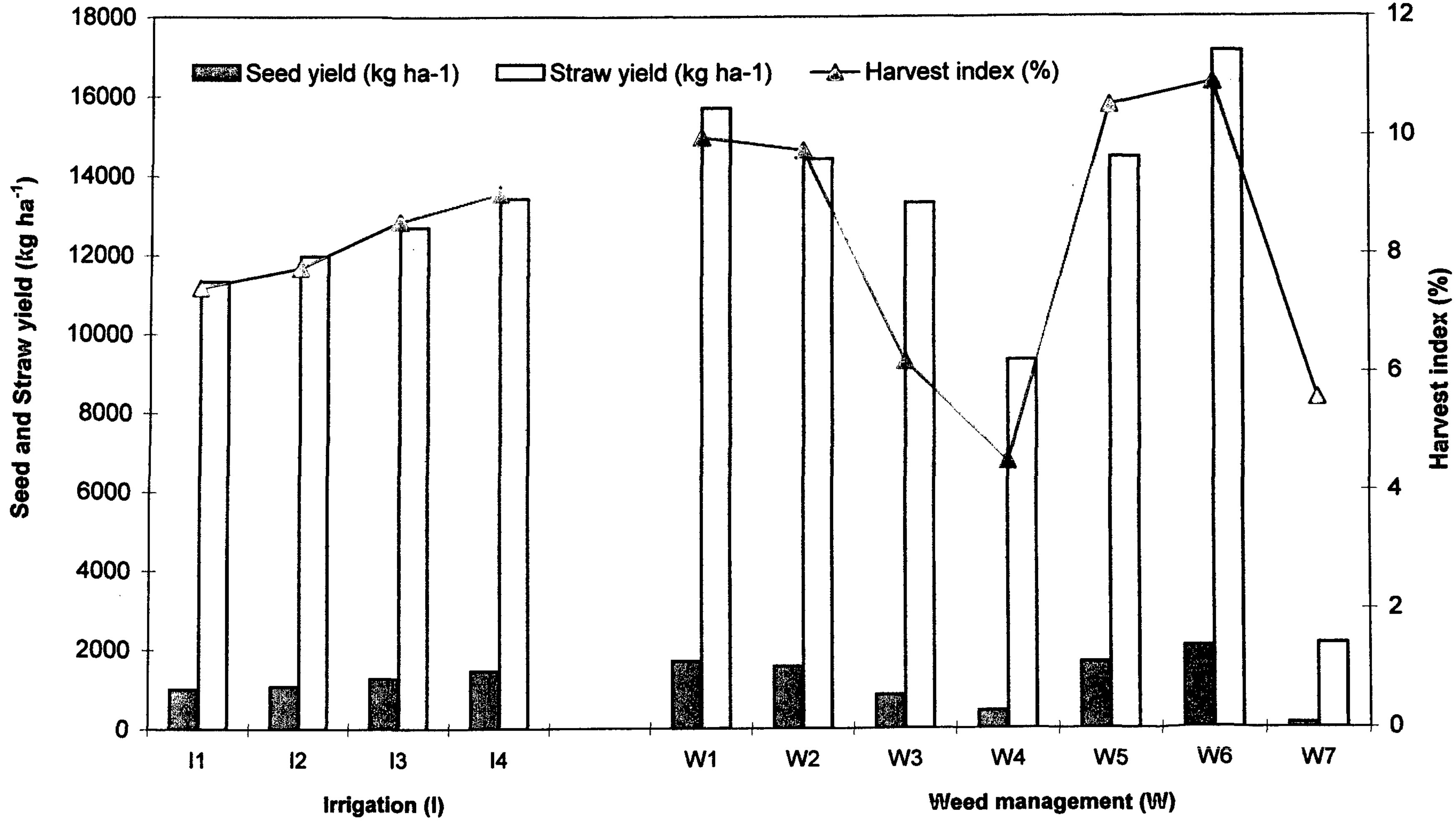



**Fig. 5.2 : Mean seed yield (kg $ha^{-1}$), straw yield (kg $ha^{-1}$) and harvest index (%) as influenced by irrigation schedules and weed management practices**

seed yield was observed under treatment $I_1$ (1004 kg $ha^{-1}$) in pooled analysis. The increase in seed yield under $I_4$ treatment was 45.3, 35.3 and 14.3 per cent over $I_1$, $I_2$ and $I_3$, respectively in pooled analysis. The maximum seed yield was recorded under the treatment $I_4$ appeared to have been resulted due to integrated effect on growth characters and yield attributes *viz.,* plant height (Table 4.2), branches $plant^{-1}$ (Table 4.9), number of umbels $plant^{-1}$, umbellates $umbel^{-1}$ and seeds $umbellate^{-1}$. Thus, from all the measurable sources evaluated in the present study, it is proved that scheduling irrigation according to treatment $I_4$ (0.40 IW : CPE) was optimum for potential production of dill seed. The result was closely accordance with Modi (1990) in dill seed and Patel *et al.* (2000) in fennel. The reduction in seed yield under $I_1$, $I_2$ and $I_3$ can be explained on this basis of internal water status in relation to different physiological process taking place in the plant body. Based on the function behaviour of water in relation to the production process of photosynthesis taking place in the plant. Slatyer (1969) concluded that moisture status in cycle within the plant is related to water supply in the soil as well as the capacity for absorption. Again a reduced water supply leads to keep the stomata closed, and even impair actual process of photosynthesis. Closed stomata will tend to raised body temperature consequently increasing respiration process that leads to breakdown of assimilates (Kramer 1969). Thus, scheduling irrigation under $I_1$, $I_2$ and $I_3$ had created an internal moisture deficit, which adversely affected physiological process in the plant as explained earlier. As a result of lower growth characters and yield attributes in these treatment lead ultimately to reduction in the yield as against treatment $I_4$ (scheduling irrigation at 0.40 IW : CPE ). This finding showed that an irrigation schedule based on IW : CPE of 0.40 produced maximum seed yield than irrigation at different vegetative growth stages of dill seed.

The straw yield increased with increasing in irrigation frequencies. The treatment $I_4$ (IW : CPE 0.40) recorded the maximum straw yield (13422 kg $ha^{-1}$) followed by the treatment $I_3$ (12698 kg $ha^{-1}$), $I_2$ (11970 kg $ha^{-1}$) and $I_1$ (11334 kg $ha^{-1}$) in pooled analysis. The percentage increase in the straw yield with the treatment $I_4$ was 15.6, 10.8 and 5.4 over that of $I_1$, $I_2$ and $I_3$, respectively in the pooled analysis. The increasing trend in straw yield with increasing irrigation frequencies (5 irrigations) might be attributed to corresponding increase in the morphological parameters *viz.,* plant height (Table 4.2) and number of branches $plant^{-1}$ (Table 4.5). Thus, an excess supply of water lead to excess vegetative growth and resulted in to higher straw yield. Similar, trend in response of cumin to different IW : CPE was reported and discussed by Lal (1969), Chandola *et al.* (1970), Sharma and Agarwal (1978), Mann (1980), Tanwar (1982) and Patel (1989).

The experimental results in respect to harvest index (Table 4.8), irrigation schedules showed significant difference in harvest index of dill seed during both the years of investigation as well as in combined analysis. Significantly higher harvest index was observed under treatment $I_4$, which did not differ with $I_3$, while the lowest harvest index noticed in treatment $I_1$ which was at par with $I_2$ in pooled analysis. This might be due to better distribution of assimilates from source to sink and comparatively lesser into vegetative parts. This finding is in accordance with finding of Vadodaria (2000) in wheat crop.

### 5.2.4 Effect on oil content

It is apparent from the data presented in Table 4.14 that the oil content was significantly influenced by irrigation levels during both the years and in pooled results. Significantly maximum oil content was reported with $I_3$ treatment, while remaining all the treatments were at par with each other in both the years and in pooled analysis. Similarly Amin and Patel (2001) also reported increasing trend in oil content with increasing IW : CPE from 0.60 to 1.00 in cumin.

### 5.2.5 Effect on nutrient uptake by dill seed

Data presented in Table 4.15 showed the significant influence of irrigation schedules on nutrient uptake by seeds *viz.,* N, $P_2O_5$ and $K_2O$. Significantly higher nutrient uptake was registered under treatment

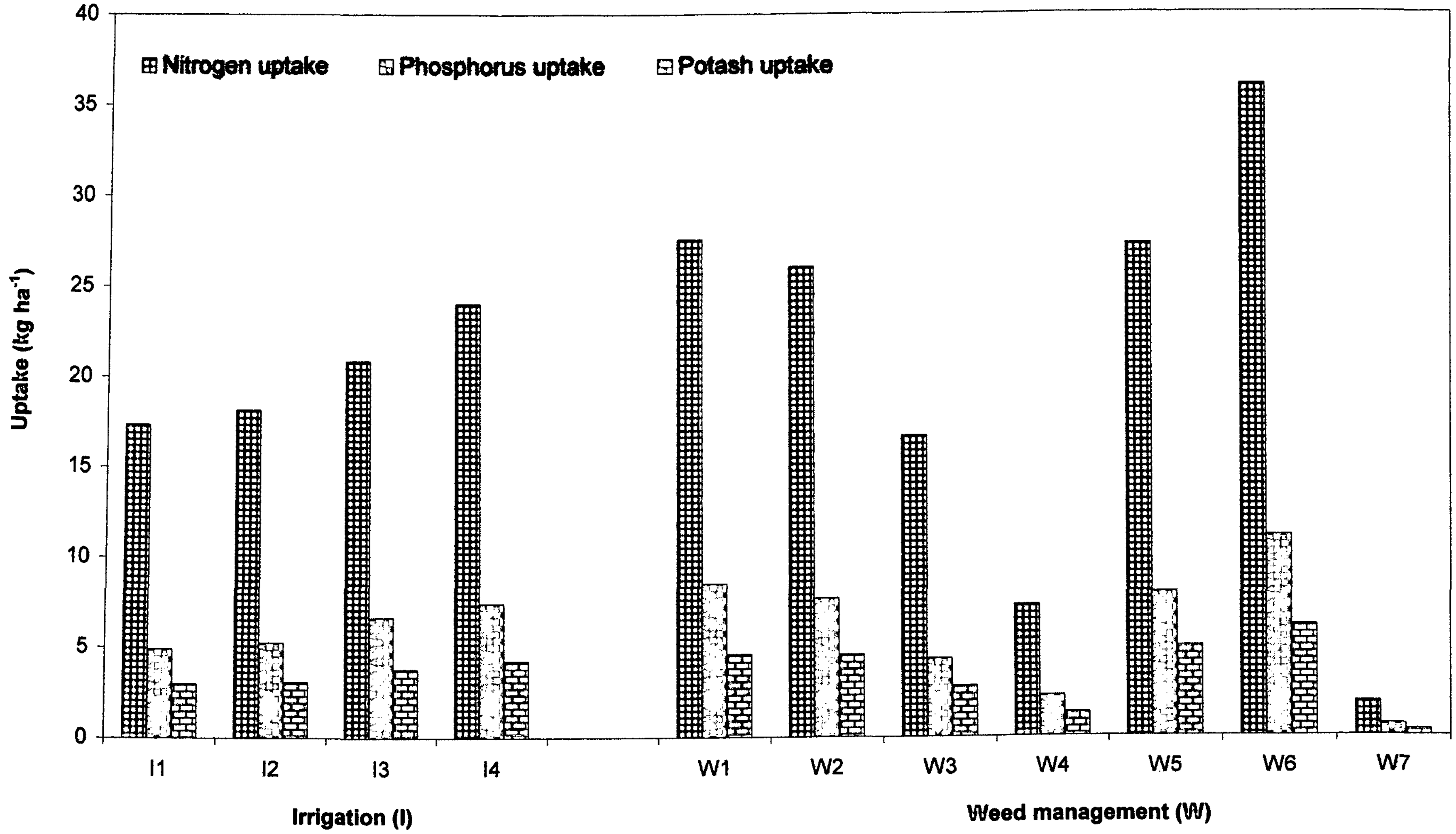



**Fig. 5.3 : Mean nitrogen, phosphorus and potash uptake (kg $ha^{-1}$) by seeds as influenced by irrigation schedules and weed management practices**

$I_4$ (IW : CPE 0.40). The lower nutrient uptake was observed with treatment $I_1$ (irrigation at vegetative stage) while, in case of $P_2O_5$ and $K_2O$ uptake, $I_1$ and $I_2$ remained at par (Fig. 5.3). In the case of nutrient uptake by straw (Table 4.19), N and $K_2O$ uptake by straw was significantly influenced by irrigation, while $P_2O_5$ uptake was not significant during both the years of study. The highest uptake was observed in treatment $I_4$ while lowest uptake under $I_1$ which was statistically not differed with $I_2$. The increase in nutrient uptake with increasing in irrigation schedules might be due to increase in nutrient availability and nutrient uptake was depending on yield and nutrient content in the seed and straw. Higher irrigation frequencies increased the availability of nutrients and thus enhanced the uptake of nutrients which in turn enhanced the meristematic activities, and size of cell and formation and functioning of protoplasm which consequently improved the crop growth and yield. This result confirmed those of Yadav *et al.* (2005) in fennel.

### 5.2.6 Effect on water use efficiency (WUE)

It is evident from the data presented in Table 4.21 that the WUE was significantly decreased with increasing in irrigation frequencies from $I_1$ to $I_4$. The lowest water use efficiency was noticed with treatment $I_4$ and higher under treatment $I_1$. The WUE depends on two factors namely yield and seasonal consumptive use (CU) of water with the increase in the irrigation frequency. The seasonal CU of water increases, which may lower the water use efficiency of the crop. Similar finding was also reported by Kumar *et al.* (2002) in fennel. Begg and Tomer (1976) reported that plant may extract water from deeper moist soil layer under stress condition but the unavailability of nutrients in upper dry surface soil may reduce the crop yield and WUE.

**5.2.7 Effect on weeds**

The weed population tabulated in Table 4.24, 4.25 and 4.26 revealed that the number of monocot, dicot and total weeds $m^{-2}$ recorded at 3 and 6 WAS and at harvest remained unaffected due to different irrigation schedules (Fig.5.4) during both the years of investigation and in pooled analysis.

Non significant differences in the counts of monocot, dicot and total weeds at 3 and 6 WAS might have been due to the fact that they exhibited no distinct differences in the irrigation treatments during the initial stage of crop growth. Like wise same trend of weed counts also observed at harvest of crop, might have been due to the fact that higher irrigation frequencies increased higher vegetative growth of crop, which might be suppressed the weed germination due to shadding effect of crop.

In general, the infestation of dicot weeds was higher than that of monocot weeds in all the treatments at all the stages of observation

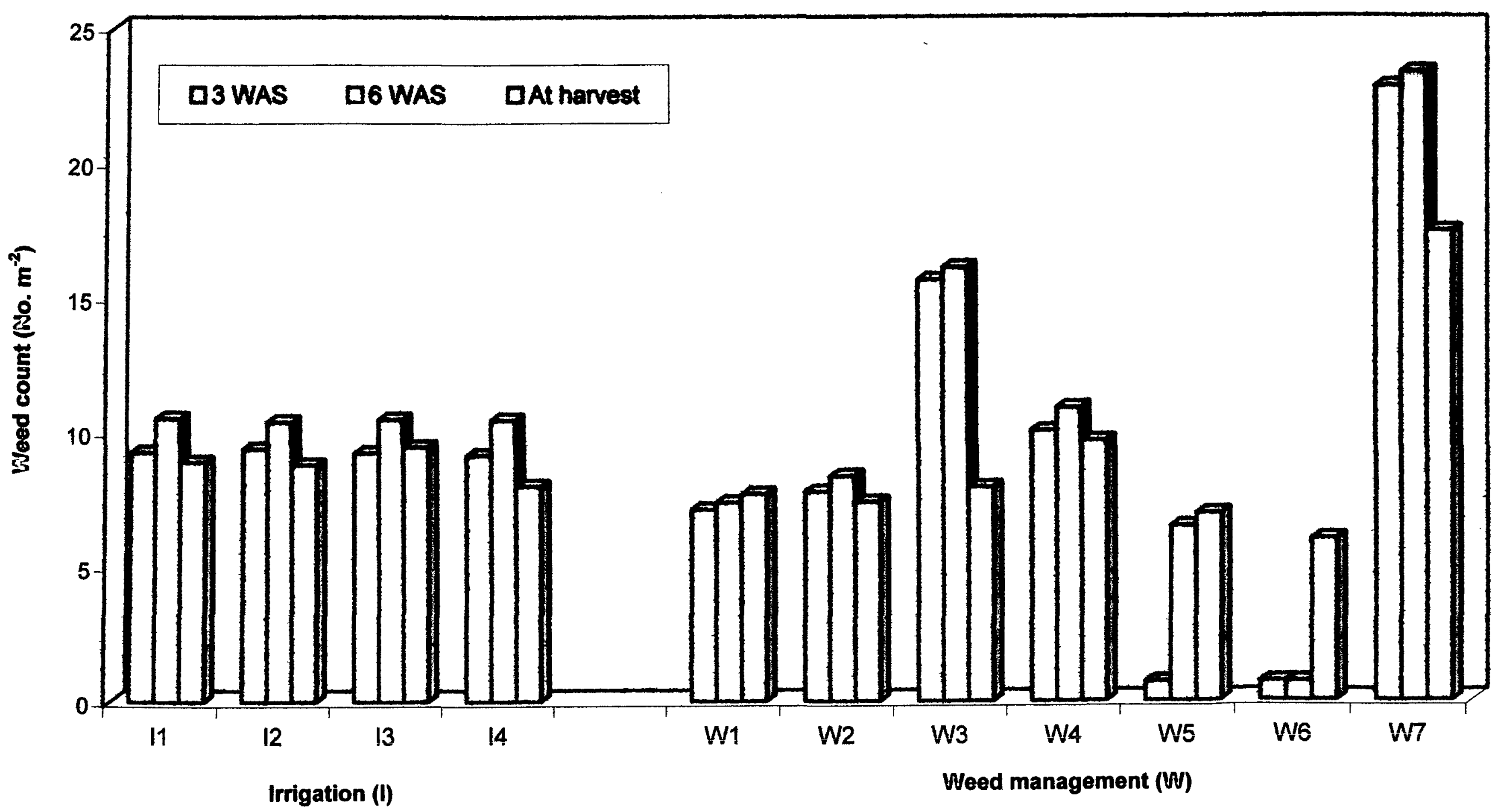



**Fig. 5.4 : Mean weed count at 3 and 6 WAS and at harvest as influenced by irrigation schedules and weed management practices**

during both the years. It was also observed that the monocot and dicot weed population increasing from 3 to 6 WAS then decreased at harvest. This might have apparently been due to the germination of the second flush at 6 WAS owing to increased availability of soil moisture on account of irrigation applied at vegetative growth stage which lead to higher weed population at 6 WAS as compared to 3 WAS and at harvest.

The dry matter accumulation of weeds (Table 4.27) recorded at 3 and 6 WAS and at harvest was also not influenced significantly due to irrigation treatments during both the years of investigation and in pooled results. Similar results were also reported by Naik *et al.* (1997). They clearly indicated that weed population remained unaffected due to various moisture regimes.

**5.2.8 Effect on nutrient uptake by weeds**

It is clear from the data presented in Table 4.32 that N nutrient uptake by weeds was significant during both the years as well as in pooled analysis. $P_2O_5$ and $K_2O$ uptake were non significant due to various irrigation schedules in pooled analysis. Significantly the highest N uptake by weeds was recorded in $I_2$. Vadodaria (2000) reported non significant differences in uptake of N, $P_2O_5$ and $K_2O$ by weeds in wheat field due to various irrigation schedules.

## 5.3 EFFECT OF WEED MANAGEMENT PRACTICES ON CROP AND WEEDS

### 5.3.1 Effect on growth characters

Growth characters *viz.,* plant population (Table 4.1), plant height (Table 4.2), number of branches plant$^{-1}$ (Table 4.5), days to 50 % flowering and days to maturity (Table 4.7) were recorded under the present investigation.

Data on germination of dill seed recorded at 10 DAS indicated that plant population significantly affected by weed management practices during both the years of investigation. The plant population was lower under treatment $W_4$ (oxadiargyl 100 g ha$^{-1}$ as PE). Which indicated toxicity effect of oxadiargyl on germination. Yadav *et al.* (2004) also reported phytotoxicity of oxadiargyl on plant stand of cumin.

The highest plant height recorded at 6, 12 and 18 WAS and at harvest as well as number of branches plant$^{-1}$ recorded at harvest were registered under treatment $W_6$ (HW at 3 and 6 WAS), while the lowest under treatment $W_7$ (Weedy check) during both the years of study and in pooled analysis. The increase in plant height and number of branches plant$^{-1}$ at harvest under treatment $W_6$ were 59.8 and 62.8 percent over treatment $W_7$, respectively in pooled analysis. The lower weed population under this treatment leads to decrease crop-weed competition, which provided

Plate 5.1: Effect of fluchloralin 1.0 kg $ha^{-1}$ on growth of dill seed at 45 DAS

Plate 5.2: Effect of pendimethalin 1.0 kg $ha^{-1}$ on growth of dill seed at 45 DAS

Plate 5.3: Effect of metolachlor 1.0 kg $ha^{-1}$ on growth of dill seed at 45 DAS

Plate 5.4: Effect of oxadiargyl 100 g $ha^{-1}$ on growth of dill seed at 45 DAS

Plate 5.5: Growth of dill seed in non chemical treatment(HW at 3 & 6 WAS)

Plate 5.6: Growth of dill seed in weedy check at 45 DAS

congenial condition for plant growth in respect to plant height and number of branches plant$^{-1}$. Similar results were obtained with respect to number of branches plant$^{-1}$ in cumin by Chaudhary and Gupta (1991).

Among herbicidal treatments, $W_1$ (fluchloralin 1.0 kg ha$^{-1}$ as PE) was the best in respect to plant height at various stages of crop and number of branches plant$^{-1}$ at harvest as compared to $W_2$ (pendimethalin 1.0 kg ha$^{-1}$ as PE) and $W_3$ (metolachlor 1.0 kg ha$^{-1}$ as PE). While $W_4$ (oxadiargyl 100 g ha$^{-1}$ as PE) was poor in respect of these parameters. This might be due to toxicity of oxadiargyl on the dill seed crop.

The days to 50% flowering and days to maturity (Table 4.7) were statistically differed due to different weed management practices. The least number of days required for 50% flowering (88.88 days) was registered with treatment $W_7$. The second most effective treatment was $W_1$ (fluchloralin 1.0 kg ha$^{-1}$ as PE) which was at par with $W_3$ (metolachlor 1.0 kg ha$^{-1}$ as PE), $W_4$ (oxadiargyl 100 g ha$^{-1}$ as PE), $W_5$ (HW at 3 WAS and earthing up at 6 WAS). Treatment $W_6$ (HW at 3 and 6 WAS) was responsible for maximum delay in 50% flowering (86.59 days) which was at par with $W_2$ (pendimethalin 1.0 kg ha$^{-1}$ as PE) in pooled analysis.

The data pertaining to days to maturity revealed that significantly higher number of days (146.22) required by the crop to attain physiological maturity under treatment $W_6$ which was higher over rest of the treatments.

Significantly lesser number of days was noticed with treatment $W_7$ (weedy check) which was however differ significantly from rest of the treatments. All herbicidal treatments are almost equally effective and matured earlier at the same time than $W_6$ (HW at 3 and 6 WAS).

### 5.3.2 Effect on yield attributes

It is evident from the data presented in Table 4.8 that the number of umbels plant$^{-1}$, umbellates umbel$^{-1}$ and seeds umbellate$^{-1}$ were significantly influence by weed management practices. The higher number of all above attributes were registered with treatment $W_6$ (HW at 3 and 6 WAS), while lower under the treatment $W_7$ (Weedy check). This might be due to fact that lower weed population in respective treatments lead to reduce competition for light, water and nutrients resulting into favourable micro environment for crop growth vegetatively as well as reproductively from initial growth stage to harvest. These findings are in close accordance with Kothari *et al.* (1989) with pre emergence application of pendimethalin 1.0 kg ha$^{-1}$ in coriander.

Among herbicidal treatments, $W_1$ (fluchloralin 1.0 kg ha$^{-1}$ as PE) registered significantly higher number of umbels plant$^{-1}$, number of umbellates umbel$^{-1}$ and number of seeds umbellate$^{-1}$ over $W_2$

(pendimethalin 1.0 kg $ha^{-1}$ as PE), $W_3$ (metolachlor 1.0 kg $ha^{-1}$ as PE) and $W_4$ (oxadiargyl 100 g $ha^{-1}$ as PE). Better growth attributes on account of superior weed controlling characteristic of fluchloralin lead to higher number of umbels, umbellates and number of seeds $umbel^{-1}$.

The test weight (Table 4.13) remained unchanged due to different weed management practices. Numerically higher test weight was registered in treatment $W_3$. Jangir and Singh (1996) also reported non significant differences in test weight of cumin due to irrigation frequencies from 4 to 6 at various growth stages.

### 5.3.3 Effect on seed and straw yield and harvest index

The seed and straw yield (Table 4.11) were appreciably influenced due to weed management measures during both the years of study and in pooled analysis.

Significantly the highest seed yield (2073 kg $ha^{-1}$) was recorded under treatment $W_6$ (HW at 3 and 6 WAS) while, the presence of weeds throughout the crop season in $W_7$ (Weedy check) registered significantly the lowest seed yield (118 kg $ha^{-1}$) of dill seed in pooled analysis. The percent reduction in seed yield under $W_7$ over $W_6$ was 94.3. Herbicidal treatment $W_1$ (fluchloralin 1.0 kg $ha^{-1}$ as PE) was next the best treatment after $W_6$ (HW at 3 and 6 WAS) followed by $W_5$ (HW at 3 WAS and earthing up at 6 WAS) and $W_2$ (pendimethalin 1.0 kg $ha^{-1}$ as PE). Higher yield in above treatments were associated with significant increase in yield attributing characters and weed control efficiency. This helped the crop plants in increasing the availability of soil moisture and plant nutrients. Similar results were recorded by Barevadia *et al.* (1995) in dill seed and Kothari *et al.* (1989) in coriander.

Significantly the highest straw yield (17135 kg $ha^{-1}$) was recorded with treatment $W_6$. Herbicidal treatments were faired poorly as compared to $W_6$ in terms of straw yield. Significantly the lowest straw yield (2135 kg $ha^{-1}$) was registered under the weedy check ($W_7$) treatment. Superior growth parameters under $W_6$ must ultimately have contributed to higher straw yield. Yadav *et al.* (2004) also reported significantly highest stover and seed yield of cumin under hand weeding treatment which was not at par with application of fluchloralin or pendimethalin 1.0 kg $ha^{-1}$

Harvest index (Table 4.11) was significantly differed due to various weed management practices. The higher harvest index was recorded with treatment $W_6$ which remained at par with $W_5$ While, lower harvest index was noticed with treatment $W_7$. The higher harvest index in $W_6$ was due to better return of economical yield in comparison to biological yield.

### 5.3.4 Effect on oil content

Oil content (%) of dill seed analysed at harvest was significant due to weed management practices during the year 2003-04 and in pooled analysis. The maximum oil content in dill seed was recorded with treatment $W_6$ in pooled analysis, which remained at par with $W_7$, while minimum oil content observed with $W_2$, which was at par with $W_1$, $W_3$, $W_4$ and $W_5$.

### 5.3.5 Effect on nutrient uptake by dill seed

Weed management treatments caused significant variation in nutrient uptake (N, $P_2O_5$ and $K_2O$) by seeds and straw during both the years of study and in pooled results (Table 4.15). The higher uptake was observed in treatment $W_6$ due to better weed control efficiency and lowest dry matter accumulation of weeds under weed free situations tended to reduce crop weed competition which resulted in higher uptake by dill seed crop. The lower uptake was observed with treatment $W_7$ (weedy check). Vadodaria (2000) reported same trend of removal of nutrients by weeds in wheat crop grown on sandy loam soil.

### 5.3.6 Effect on water use efficiency (WUE)

The data on water use efficiency presented in Table 4.21 revealed that different weed management measures significantly influenced the water use efficiency. The highest water use efficiency was recorded under $W_6$ followed by $W_1$ (fluchloralin 1.0 kg $ha^{-1}$ as PE) and $W_5$ (HW at 3

WAS and earthing up at 6 WAS) during both the years of investigation as well as in pooled data. The lowest water use efficiency was recorded under weedy check ($W_7$). Effective weed control achieved through different weed control treatments reduced the crop weed competition with respect to soil moisture, nutrients depletion and space for growth therefore more water provided to the crop to yield more, which gave higher values of WUE.

### 5.3.7 Effect on weed growth

In general, the dicot weeds infestation was higher than the monocot weeds at all the stages of crop growth. Weed population counted at 3 and 6 WAS and at harvest revealed that the weed density was considerably reduce under effective weed management measures (Table 4.24, 4.25 and 4.26 ) during both the years of investigation. All the weed control treatments significantly reduced the weed counts (monocot, dicot and total) as compared to weedy check at all the growth stages.

Significantly the highest number of monocot, dicot and total weeds were recorded under treatment $W_7$ (Weedy check) during both the years of study and in pooled analysis at all the three stages (3 and 6 WAS and at harvest). The lowest weed counts were observed with treatment $W_6$ ( HW at 3 and 6 WAS).

Among herbicidal treatments, $W_1$ (fluchloralin 1.0 kg $ha^{-1}$ as PE) was the best treatment in controlling the monocot, dicot and total

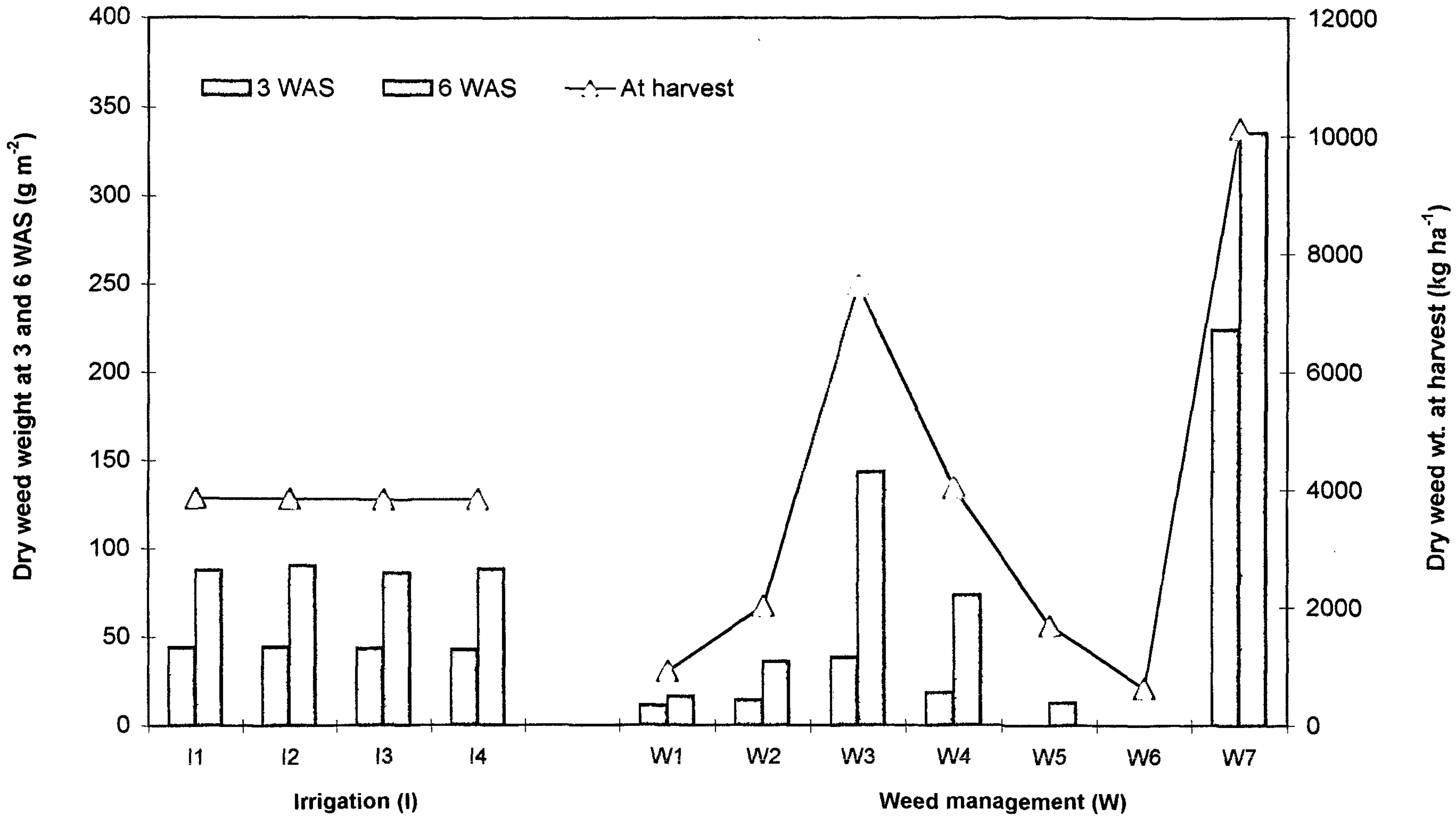



**Fig. 5.5 : Mean dry weed weight at 3 and 6 WAS (g $m^{-2}$) and at harvest (kg $ha^{-1}$) as influenced by irrigation schedules and weed management practices**

weeds. $W_3$ (metolachlor 1.0 kg $ha^{-1}$ as PE) was the most inferior among the chemical herbicidal treatments, it might be due to failed in controlling the weeds. Yadav *et al.* (2005) also recommended twice hand weeding (25 and 50 DAS) in cumin crop and was the best treatment in reducing weeds effectively. Among herbicides, pendimethalin and fluchloralin were effective to control weeds in cumin.

Effective control of weeds resulted from different weed management treatments reduced the weed counts considerably which might have reflected in reduced dry weight of weeds by these treatments. Similar findings were also observed by Chaudhary and Gupta 1991), Gora *et al.* (1996) and Mehta *et al.* (1985) in cumin.

Dry weight of weeds (Table 4.27) recorded at 3 and 6 WAS and at harvest was found significantly the highest in weedy check ($W_7$). All weed management treatments reduced the dry weight of weeds significantly over weedy check ($W_7$). The lowest dry weight of weeds was registered with treatment $W_6$ followed by $W_1$, $W_5$, $W_2$, $W_3$ (Fig.5.5). Similar results were also reported by Chaudhary and Gupta (1991), Gora *et al.* (1996) and Mehta *et al.* (1985) in cumin.

### 5.3.8 Effect on weed control efficiency (%)

The weed control efficiency (WCE) is the function of total quantity of weeds in the control and treated plots in the present investigation. The data on WCE (Table 4.30) indicated that the higher WCE was recorded in the treatments $W_6$ (HW at 3 and 6 WAS) at harvest and was followed by $W_1$, $W_5$, $W_2$ and $W_3$. The least WCE was observed in pre emergence application of metolachlor 1.0 kg $ha^{-1}$ ($W_3$) among the herbicidal treatments. Chaudhary (2000) also noticed only 10.5 percent weed control efficiency under pre emergence application of metolachlor 1.0 kg $ha^{-1}$ in fennel due to poor control of *rabi* weeds. Pre emergence of fluchloralin 1.0 kg $ha^{-1}$ was at top. This was mainly because of the effective check in the dry matter accumulation of weeds, similar findings were also observed by Kothari *et al.* (1989) in coriander and Patel and Mehta (1989) in cumin.

### 5.3.9 Effect on weed Index

It was evident from the data presented in Table 4.31 that the higher harvest index (94.29 %) was recorded with weedy check ($W_7$) due to higher weed count and dry matter accumulation by weeds. The lowest weed index was registered by treatment $W_6$ (HW at 3 and 6 WAS) followed by $W_1$ : fluchloralin 1.0 kg $ha^{-1}$ as PE (17.51 %), $W_5$ : HW at 3 WAS and earthing up at 6 WAS (19.35 %) and $W_2$ : pendimethalin 1.0 kg $ha^{-1}$ as PE (24.89). It might be due to the lower dry matter accumulation by weeds.

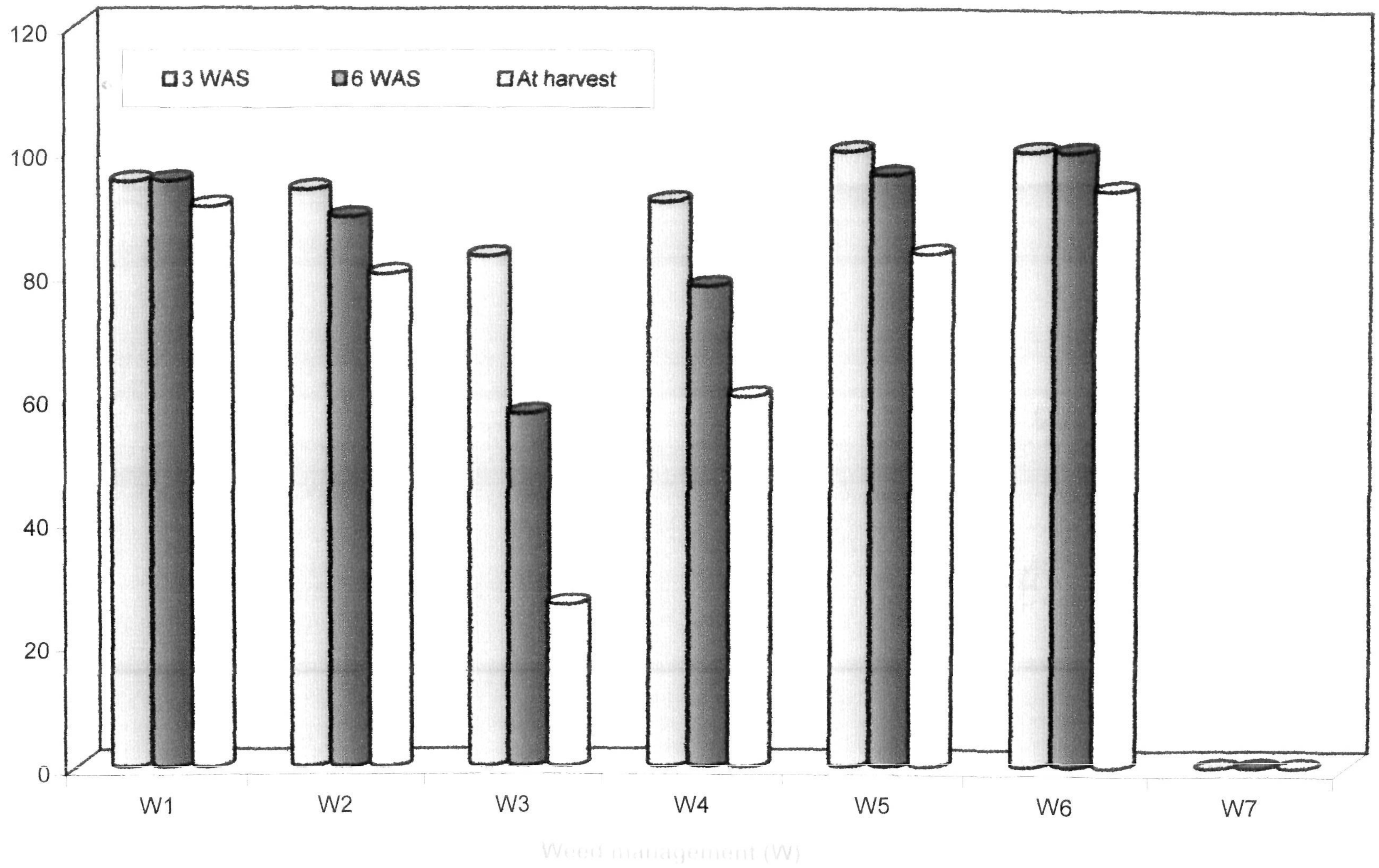



**Fig. 5.6 : Mean weed control efficiency (%) as influenced by weed management practices**

### 5.3.10 Effect on nutrient uptake by weeds

The nutrient uptake (N, $P_2O_5$ and $K_2O$) by weeds was significantly influenced due to weed management treatments (Table 4.32). The uptake of N, $P_2O_5$ and $K_2O$ by weeds was noticed Significantly the highest and lowest in weedy check ($W_7$) and HW at 3 and 6 WAS ($W_6$), respectively. The lowest uptake of these major nutrients by weed was associated with the lowest dry matter accumulation of weeds which could be attributed to efficient control of weeds under weed management treatments ($W_6$). The result was close accordance with Gora *et al.* (1996) in cumin.

## 5.4 INTERACTION EFFECT OF IRRIGATION SCHEDULES AND WEED MANAGEMENT PRACTICES ON CROP AND WEEDS

In the present study, interaction effect between irrigation schedules and weed management practices for the several growth parameters, yield and yield attributes, chemical parameters and weed growth was found significant. However, only those interactions which were found significant in pooled analysis are discussed in brief in the present section.

**5.4.1 Effect on crop growth, yield attribute parameters and yield**

Plant height of dill seed recorded at 18 WAS (Table 4.3) and at harvest (Table 4.4) was significantly influenced by interactive effect of I x W. The data indicated that the treatment combination $I_4W_6$ recorded significantly the highest plant height 180.00 and 184.50 cm at 18 WAS and at harvest, respectively in pooled analysis. Weeds were completely removed at 3 and 6 WAS by manually in $I_4W_6$ treatment and five irrigations were applied at various growth stages, which had combined effect for luxurious growth of crop. Therefore plant height recorded at 18 WAS as well as at harvest was significantly superior to rest of the combinations of I x W.

The number of branches plant$^{-1}$, number of umbels plant$^{-1}$, umbellates umbel$^{-1}$ and seed yield of dill seed were also significantly influenced by interactive effect of I x W. The perusal of data presented in Table 4.6. Table 4.9, Table 4.10 and Table 4.11 indicated that the treatment combination $I_4W_6$ proved statistically superior over other combinations of I x W in respect to number of branches plant$^{-1}$ (15.65), number of umbels plant$^{-1}$ (33.01) and number of umbellates umbel$^{-1}$ (28.56) which showed directly reflection on seed yield of dill crop.

In pooled analysis, significantly higher seed yield (2376 kg ha$^{-1}$) was recorded with combination of $I_4W_6$ which was statistically at par with $I_3W_6$ (2248 kg $ha^{-1}$). This interaction gives idea that five irrigations at different stages of growth or four irrigations at various growth stages and weeds removed manually (HW at 3 and 6 WAS) in dill seed crop showed superiority in yield than rest of the combinations. Pre emergence application of either pendimethalin or fluchloralin or metolachlor with five or four irrigations at various growth stages were inferior to non chemical hand weeding combination. Dicot weeds specially *Phyllanthus niruri* L. and *Melilotus indica* L. were partially controlled by dinitroaniline herbicides (pendimethalin and fluchloralin) due to volatile nature of chemical and *Chenopodium album* L. was also partially controlled by application of metolachlor. Oxadiargyl showed toxicity on germination of dill seed. Due to these reasons yield was not at par of combinations of four or five irrigations with herbicidal treatments in pooled analysis. Oxadiargyl showed toxicity on germination which reflect on seed yield. The results on toxicity of oxadiargyl on cumin was also reported by Yadav *et al.* (2004) is conformed to this findings.

Significantly lower seed yield (78 kg $ha^{-1}$) was recorded in combination of $I_1W_7$ which was at par with $I_2W_7$ (120 kg $ha^{-1}$), $I_3W_7$ (127 kg $ha^{-1}$) and $I_4W_7$ (146 kg $ha^{-1}$). Dill seed crop is short stature might be due to this reason crop could not compete with weeds in weedy check ($W_7$) even though five irrigations were given.

Nutrient uptake *viz.,* N (Table 4.16), $P_2O_5$ (Table 4.17) and $K_2O$ (Table 4.18) by seeds were significantly influenced by interaction of irrigation schedules and weed management practices. Treatment combination $I_4W_6$ proved significantly the highest N (42.20 kg $ha^{-1}$) and $P_2O_5$ (13.71 kg $ha^{-1}$) uptake by seeds while, $K_2O$ uptake significantly higher in $I_4W_6$ (6.96 kg $ha^{-1}$) which was at par with $I_3W_6$ (6.83 kg $ha^{-1}$), $I_1W_6$ (6.93 kg $ha^{-1}$)and $I_4W_2$ (6.67 kg $ha^{-1}$) in pooled analysis.

Treatment $I_4W_6$ secured maximum yield than rest of the combinations of I x W, which directly showed effect on removal of N, $P_2O_5$ and $K_2O$ by seeds at harvest. Higher yield in $I_4W_6$ treatment associated with significantly increased in yield attributing characters and weed control efficiency. This finding is in accordance with the finding of Vadodaria (2000) who reported higher removal of NPK by grain and straw of wheat in combination of seven irrigations at various growth stages with pre emergence application of pendimethalin 1.0 kg $ha^{-1}$ grown on sandy loam soil in *rabi* season.

**Water use efficiency**

The treatment combination $I_1W_6$ recorded significantly the highest (14.49 %) water use efficiency in pooled analysis. The lowest water use efficiency was recorded in $I_4W_7$ (0.49 %) which was at par with $I_3W_7$ (0.51 %), $I_1W_7$ (0.53 %) and $I_2W_7$ (0.60 %) in pooled data. Lower wter use efficiency under higher frequencies of irrigation was because of proportionately more loss of water through evapotranspiration than the relative increase in dill seed yield.

### 5.5 Economics

The acceptance of improved production technology involving scare input like irrigation and weed management treatments for dill seed crop by depends largely on the economic return from the inputs. In the present study to work out the economics of different treatments, cost benefits ratio (CBR) and net realization were worked out (Table 4.36 and 4.37).

#### 5.5.1 Effect of water management on economics

Among various irrigation schedules, irrigating the dill seed at 0.40 IW : CPE ($I_4$) recorded the highest net realization of Rs. 8078 $ha^{-1}$ with cost benefit ratio (CBR) 1:1.57 (Table 36). This was followed by irrigating dill seed crop at three critical ($I_3$) crop growth stages (vegetative, 50% flowering and seed formation stages) with net returns of Rs. 6332 $ha^{-1}$ with CBR 1:1.48. The lowest net realization of Rs. 3882 was recorded under treatment $I_1$ (irrigation at vegetative stage). The higher net realization in 0.40 IW : CPE was due to the favourable effect of adequate soil moisture on plant growth. Similar results were also reported by Modi (1990) in the case of dill seed and Joshi (2002) in the case of fennel.

Thus, all the measurable sources evaluated in the present study proved that irrigation scheduling at 0.40 IW : CPE were found better for securing profitable seed yield of dill seed under sandy loam soil. Patel *et al.* (2000) also reported maximum net return in 1.00 IW : CPE than 0.80 and 0.60 IW : CPE in cumin crop.

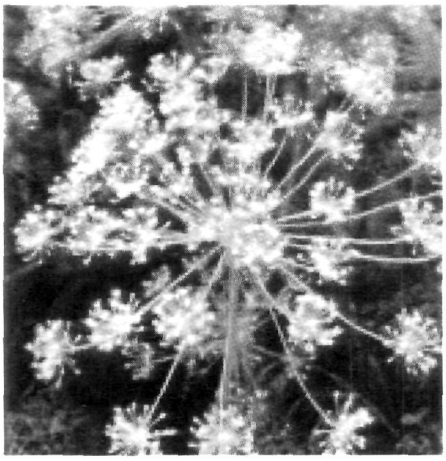
**5.5.2 Effect of weed management practices on economics**

The highest net return of Rs. 15471 $ha^{-1}$ and CBR of 1:2.21 were recorded with hand weeding at 3 and 6 WAS ($W_6$) followed by application of fluchloralin 1.0 kg $ha^{-1}$ as PE ($W_1$) and HW at 3 WAS with earthing up at 6 WAS ($W_5$) with net returns of Rs. 11235 and 11090 $ha^{-1}$ with CBR of 1:1.94 and 1: 1.95, respectively. The lowest net return (loss of Rs. 6296 $ha^{-1}$) was recorded under weedy check ($W_7$). This results confirmed those of Gora *et al.* (1996) in cumin.

Thus, evaluation of all the measurable sources proved that hand weeding at 3 and 6 WAS or pre emergence application of fluchloralin 1.0 kg $ha^{-1}$ found better for securing sustainable seed yield of dill seed.

**5.5.3 Effects of I x W on economics**

The highest net realization of Rs. 18391 $ha^{-1}$ and CBR 1:2.34 were realized by scheduling irrigation at 0.40 IW : CPE and hand weeding at 3 and 6 WAS, followed by treatment combination $I_3W_6$ (irrigations at vegetative, 50% flowering and dough seed stages combined with HW at 3



# Summary and Conclusion

# VI. SUMMARY AND CONCLUSION

The present investigation was carried out during the rabi season of 2002-03 and 2003-04 on loamy sand soil of the Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand to evaluate the **"Response of dill seed (*Anethum graveolens* L.) to irrigation and weed management practices under middle Gujarat Agro climatic condition".**

The experiment was laid out in Split Plot Design (SPD) with four replications. The treatment comprised with four irrigation schedules based on critical growth stages *viz.*, $I_1$ : Irrigation at vegetative stage, $I_2$ : Irrigation at vegetative stage and at 50 % flowering stage, $I_3$ : Irrigation at vegetative stage, at 50 % flowering stage and at dough seed stage, $I_4$ : Irrigation at 0.40 IW : CPE and seven weed management practices *viz.*, $W_1$ : fluchloralin 1.0 kg ha$^{-1}$ (pre emergence), $W_2$ : pendimethalin 1.0 kg ha$^{-1}$ (pre emergence), $W_3$ : metolachlor 1.0 kg ha$^{-1}$ (pre emergence), $W_4$ : oxadiargyl 100 g ha$^{-1}$ (Pre emergence), $W_5$ : hand weeding at 3 WAS and earthing up at 6 WAS, $W_6$ : weed free (HW at 3 and 6 WAS) and $W_7$ : Weedy check .

The results obtained in present investigation which presented and discussed in the preceding chapters have been summarized here under the following sub heads:

**6.1 Effect of irrigation schedules on crop and weeds**

**6.2 Effect of weed management practices on crop and weeds**

**6.3 Interaction effect of I x W on crop and weeds**

## 6.1 Effect of irrigation schedules on crop and weeds

Growth characters such as plant population at 10 DAS and at harvest and days to 50 % flowering remain unchanged due to various irrigation schedules.

Growth characters such as plant height, number of branches plant$^{-1}$, yield attributes such as umbel plant$^{-1}$, umbellates umbel$^{-1}$ and seeds umbellates$^{-1}$ were significantly improved with increasing number of irrigation. Significantly higher values of almost all these parameters were recorded under higher frequencies of irrigation applied at 0.40 IW : CPE ($I_4$) over other irrigation schedules during both the years as well as in pooled analysis.

Test weight of dill seed recorded at harvest remain unchanged due to irrigation schedules in individual years but found significantly higher under treatment $I_4$ in pooled analysis.

Significantly the highest seed and straw yield of dill seed were recorded under irrigation schedules of 0.40 IW : CPE ($I_4$). The increase in seed yield under $I_4$ treatment was 45.3, 35.3 and 14.3 percent over $I_1$, $I_2$ and $I_3$, respectively in pooled analysis.

Significantly higher harvest index was recorded under $I_4$ treatment, which was statistically at par with $I_3$ during both the years and in pooled data.

Significantly maximum oil content was recorded with $I_3$ treatment, while remaining all the parameters were at par with each other in both the years and also in pooled analysis.

Significantly higher nutrient uptake (N, $P_2O_5$, and $K_2O$) by dill seed was registered in treatment $I_4$ (0.40 IW : CPE) than the rest of the irrigation schedules.

The lowest water use efficiency was noticed with treatment $I_4$ (0.40 IW : CPE) and higher under treatment $I_1$ (one irrigation at vegetative growth stage) during individual years and also in pooled analysis.

The weed population of monocot, dicot and total weeds (No.$m^{-2}$) recorded at 3 and 6 WAS and at harvest remain unaffected due to different irrigation schedules during both the years of investigation and in pooled analysis.

Among different irrigation schedules, $I_4$ (0.40 IW : CPE) showed significantly lower dry weed weight which was at par with treatment $I_3$ recorded at 3 WAS and at harvest during both the years and in pooled analysis.

Significantly the highest N uptake by weeds was recorded in treatment $I_1$ while the lowest N uptake was observed in $I_4$ irrigation schedules.

The highest net return of Rs 8078 $ha^{-1}$ and CBR of 1:1.57 were secured at 0.40 IW : CPE ratio ($I_4$), followed by irrigation at vegetative, 50% flowering and dough seed stages ($I_3$). The treatment $I_1$ (irrigation at vegetative stage) recorded the lowest net return of Rs. 6332 $ha^{-1}$.

## 6.2 Effect of weed management practices on crop and weeds

Growth characters like plant population of dill seed was lower under treatment $W_4$ (oxadiargyl 100 g $ha^{-1}$ as PE) which indicated toxicity of oxadiargyl on germination of dill seed.

The highest plant height of dill seed recorded at 12 and 18 WAS and at harvest as well as number of branches $plant^{-1}$ recorded at harvest were registered under treatment $W_6$ (HW at 3 and 6 WAS). While the lowest recorded under treatment $W_7$ (weedy check) in pooled analysis.

Significantly higher number of days (146.22) required by the crop to attain physiological maturity were registered under treatment $W_6$ (HW at 3 and

6 WAS). While lesser days were required under treatment $W_7$ (weedy check) in pooled analysis.

The higher numbers of yield attributes like number of umbels plant$^{-1}$, umbellates umbel$^{-1}$ and seeds umbellate$^{-1}$ were registered with treatment $W_6$ (HW at 3 and 6 WAS). While lower of these characters were under the treatment $W_7$ (weedy check). Among herbicidal treatments, $W_1$ (fluchloralin 1.0 kg ha$^{-1}$ as PE) showed significantly higher number of yield attributes over other herbicidal treatments.

Significantly the highest seed yield (2073 kg ha$^{-1}$) and straw yield (17135 kg ha$^{-1}$) were recorded with treatment $W_6$, while the presence of weed through out the crop season ($W_7$) registered significantly the lowest seed (118 kg ha$^{-1}$) and straw yield (2135 kg ha$^{-1}$) of dill seed in pooled analysis. The higher harvest index was recorded with treatment $W_6$ which remained at par with $W_5$. While lower harvest index was noticed with treatments $W_7$.

Test weight of dill seed was not significantly affected by various weed management practices. Treatment $W_6$ recorded significantly the highest nutrient uptake *viz.*, N, $P_2O_5$ and $K_2O$ by dill seed over other weed management practices while, significantly the lowest uptake was observed under the treatment $W_7$ (weedy check).

The lowest weed density and weed dry weight were observed under treatment $W_6$ (HW at 3 and 6 WAS). Among herbicidal treatments, $W_1$ (fluchloralin 1.0 kg $ha^{-1}$ as PE) was the best treatment in controlling monocot, dicot and total weeds. While $W_3$ (metolachlor 1.0 kg $ha^{-1}$ as PE) was the most inferior among the herbicidal treatments.

The higher weed control efficiency was recorded in the treatment $W_6$ (HW at 3 and 6 WAS) at harvest and were followed by $W_1$, $W_5$, $W_2$ and $W_3$. WCE varies between 79.91 to 93.71 % in these treatments.

The uptake of N, $P_2O_5$ and $K_2O$ by weeds was noticed significantly the highest in weedy check ($W_7$) and lower in weed free (HW at 3 and 6 WAS) which was at par with treatment $W_1$.

The highest net return of Rs. 15471 $ha^{-1}$ and CBR of 1: 2.21 were recorded with HW at 3 and 6 WAS ($W_6$) followed by HW at 3 WAS and earthing up at 6 WAS ($W_5$) and pre emergence application of fluchloralin 1.0 kg $ha^{-1}$ ($W_1$) with CBR of 1:1.95 and 1:1.94, respectively.

## 6.3 Interaction effect of I x W on crop and weeds

Plant height of dill seed crop recorded at 18 WAS and at harvest was significantly influenced by interactive effect of I x W. The treatment combination $I_4W_6$ recorded significantly the highest plant height 180.0 cm and 184.5 cm at 18 WAS and at harvest, respectively in pooled analysis.

The number of branches plant$^{-1}$, number of umbels plant$^{-1}$, umbellates umbel$^{-1}$ and seed yield of dill seed were also significantly influenced by interactive effect of I x W. The treatment combination $I_4W_6$ proved statistically superiority over other combinations of I x W in respect of number of branches plant$^{-1}$ (15.65), number of umbels plant$^{-1}$ (33.01) and number of umbellates umbel$^{-1}$ (28.56) in pooled analysis.

In pooled analysis, significantly higher seed yield (2376 kg ha$^{-1}$) was recorded with combination of $I_4W_6$ which was statistically at par with $I_3W_6$ (2248 kg ha$^{-1}$). While significantly lower seed yield (78 kg ha$^{-1}$) was recorded in combination of $I_1W_7$ which was at par with $I_2W_7$ (120 kg ha$^{-1}$), $I_3W_7$ (127 kg ha$^{-1}$) and $I_4W_7$ (146 kg ha$^{-1}$).

Nutrient uptake *viz.*, N, $P_2O_5$ and $K_2O$ by seeds were significantly influenced by interaction of irrigation schedules and weed management practices. Treatment combination $I_4W_6$ proved significantly the highest N 42.20 kg ha$^{-1}$) and $P_2O_5$ (13.17 kg ha$^{-1}$) uptake by seeds while $K_2O$ uptake significantly higher in $I_4W_6$ (6.96 kg ha$^{-1}$) which was at par with $I_3W_6$ (6.83 kg ha$^{-1}$), $I_1W_6$ (6.93 kg ha$^{-1}$) and $I_4W_2$ (6.67 kg ha$^{-1}$) in pooled analysis.

The treatment combination $I_1W_6$ recorded significantly the highest water use efficiency (14.49 %) in pooled analysis. the lowest water use efficiency was recorded in $I_4W_7$ (0.49 %) which was at par with $I_3W_7$ (0.51%) and $I_2W_7$ (0.60%) in pooled analysis.

The highest net realization of Rs. 18391 $ha^{-1}$ and CBR 1:2.34 were realized by treatment combination $I_4W_6$ (scheduling irrigation at 0.40 IW:CPE ratio and removal of weeds by manually at 3 and 6 WAS) followed by treatment combination $I_3W_6$ (Irrigation at vegetative, 50% flowering and dough seed stages with HW at 3 and 6 WAS) with net returns of Rs. 17329 $ha^{-1}$ and CBR of 1:2.32.

**Conclusion**

In view of the results obtained from the present investigation, it could be concluded that.

1. Among the various irrigation schedules, applying irrigation at 0.40 IW : CPE ($I_4$) produced the highest seed yield and generated a net worth Rs. 8078 $ha^{-1}$ with a CBR of 1:1.57.
2. Among the various weed management practices, two hand weeding at 3 and 6 WAS ($W_6$) produced the highest dill seed yield and realized the highest net profit of Rs. 15471 $ha^{-1}$ with CBR of 1:2.21.
3. Interaction effect of irrigation schedules (I) and weed management practices (W) on seed yield was present. Treatment combination $I_4W_6$ produced the higher dill seed yield (2376 kg $ha^{-1}$) followed by $I_3W_6$ (2248 kg $ha^{-1}$) and generated net revenue worth Rs. 18391 $ha^{-1}$ and 17329 $ha^{-1}$ with a CBR of 1:2.34 and 1:2.32, respectively.

Thus from the point of view of productivity and economics, the dill seed crop should be irrigated either at all the critical crop growth stages (vegetative, 50% flowering and dough seed stages) or at 0.40 IW : CPE with one common irrigation for sowing to obtain high yield and net return. Maintaining a weed free plot with hand weeding at 3 and 6 week after sowing could also be preferable for sandy loam soils under the middle Gujarat condition for achieving highest yield and remuneration.

**Future thrust**

The following suggestions on the basis of the results obtained from the present investigation have been made in order to carry out further research on the same lines.

- Higher levels of IW : CPE ( > 0.40) should be tested for higher production of dill seed.
- Such studies should also be conducted under different agro-climatic conditions on different soils with different weed flora.
- New molecules of herbicide be tested for effective weed control and obtaining higher profitable dill seed yield
- To know phytotoxicity to dill seed, herbicide application methods should be tested in various irrigation schedules.

- Study may be carried out to evaluate the residual effect of herbicides on succeeding sensitive crops.
- Studies on herbicide residue in crop produces, soils and water also needed for soil health.
- Application of herbicide with one hand weeding may be tested as an integrated measure to get season long weed free condition for better production

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